KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: DECEMBER 1, 1890.

CONTENTS.

Plesiosaurs or Long-Necked Sea-Lizards. By R. LYDEKKER, B.A.Cantab 263
What is a Haze? By Dr. J. G. MCPHERSON, F.R.S.E. ... 265
Insectivorous Plants. By J. PENTLAND SMITH, M.A., B.Sc. 266
On the Conservation of Energy.—II. By J. J. STEWART 269
Is the Moon Covered with Ice? By A. C. RANYARD ... 271
Notices of Books 273
Letters:—J. WILLIS; J. SHAW; F. PINCOTT; J. BURGESS .. 273
Whin Blossom and other Explosive Flowers. By the Rev. ALEX. S. WILSON, M.A., B.Sc. 274
The Bed-Bug.—IV. By E. A. BUTLER... 275
Magic Squares. By A. C. RANYARD 277
Whist Column. By W. MONTAGU GATTIE, B.A.Oxon. ... 280
The Face of the Sky for December. By HERBERT SADLER, F.R.A.S. 281
Chess Column. Conducted by I. GUNSBERG 282

PLESIOSAURS OR LONG-NECKED SEA-LIZARDS.

By R. LYDEKKER, B.A.Cantab.

IN a former article* we gave a description of the remains of those remarkable marine reptiles from the secondary rocks known as Fish-Lizards, or Short-Necked Sea-Lizards; the general geological relations of the secondary rocks, in which their remains occur, being then noticed in such a manner that any further allusion to them on the present occasion would be superfluous. The Fish-Lizards were, however, by no means the only reptilian inhabitants of those ancient seas in which the secondary rocks were deposited. On the contrary, they were accompanied by another group of marine reptiles, equally well adapted for a maritime life, but presenting such a totally different type of structure that no one can have any difficulty in distinguishing between the two. So different, indeed, are the skeletons of these two groups of creatures, that with very little instruction every person of ordinary ability ought at once to be able to say to which of the two any single bone he may pick up should be referred. Since the most striking feature in the skeleton of these reptiles, and also one whereby they are very broadly distinguished from the Fish-Lizards, is the great length of the neck (Fig. 1), they may be conveniently known as Long-Necked Sea-Lizards. Should, however, any of our readers have a fancy for a shorter and more technical term, there is one ready to his hand in the name Plesiosaur. Speaking of the long neck of these reptiles forcibly reminds the writer of a noteworthy answer he once received, when examiner at the Calcutta University, from a Bengali Babu, in reply to a question as to the chief points of difference between a Fish-Lizard, or Ichthyosaur, and a Plesiosaur. The misguided student, apparently from having read that portions of the fossilised integuments of the Ichthyosaurs had been obtained, answered the question by stating that Ichthyosaurs were reptiles with a skin, but without a neck, while Plesiosaurs had a neck but no skin.

Like the Fish-Lizards, the Long-Necked Sea-Lizards lived throughout the whole of the secondary period. Their skeletons, although far less common than those of the Fish-Lizards, are preserved in an equally fine state of preservation in the Lias clays of Lyme-Regis and Whitby. Several of the species from the Lias are of comparatively small dimensions, not attaining a length of more than some 8 or 10 feet; but other kinds, more especially those found in the higher oölitic and cretaceous rocks, were of enormous dimensions, reaching to a length of 40 feet.

Our earliest knowledge of these strange creatures was mainly derived from the observations of the Rev. Mr. Conybeare and Dean Buckland, made in the earlier decades of the present century. So monstrous and strange did the skeletons of these reptiles appear to those early pioneers in the study of fossil animals, that they were not inaptly compared to a snake threaded through the body of a turtle.

The easiest manner in which we may gain a general idea of the structure of these reptiles will be by comparing them with the Fish-Lizards, of which the chief features of the skeleton have been described in the article already quoted. Apart from the great difference in the length of the neck, one of the most striking points of distinction between the Fish-Lizards and the Long-Necked Lizards is to be found in the structure of their paddles. Thus, it will be remembered, in the former group the bone of the arm was extremely short, while all the bones of the forearm, wrist, and fingers were modified into a polygonal shape, and articulated together so as to convert the whole framework of the limb into a solid pavement-like structure.

In the Long-necked Lizards, on the other hand, the arm bone (as seen in Fig 1) is comparatively long, and shaped somewhat like a flattened club; while the bones of the forearm (Fig. 2), although remarkably short and flat, are by no means so short as they are in the Fish-Lizards. The greatest difference in the structure of the paddle is, however, to be found in the form of the bones of the fingers (Fig. 1), which, in place of being polygonal, are long and slender like those of ordinary reptiles. It is true, indeed, that the number of bones in each finger is considerably greater than in living reptiles, but the number of the fingers themselves does not exceed the normal five, and the bones of each finger are entirely disconnected from those of the adjacent fingers. The above essential differences in the structure of the paddles of the Long-Necked Lizards from those of the Fish-Lizards will be apparent by comparing Figs. 1 and 2 with the corresponding figures in the article on the former group. It was probably on account of the structure of the paddles, which departs less from the ordinary type than is the case with the Fish-Lizards, that Mr. Conybeare was led to propose the name Plesiosaur, derived from the Greek *plesios*, nearer, and *sauros*, a lizard.

Equally remarkable differences occur in the form and arrangements of the bones of the shoulder and haunches; but since their illustration would require a long detailed

* KNOWLEDGE, November 1889.

description, we shall pass them by, only mentioning that in the Long-Necked Lizards they form very large plate-like expansions on the lower aspect of the body.

A glance at the figures of the two creatures will at once show a great difference in the relative size of their skulls; that of the Long-Necked Lizard being comparatively short and stout, and thus adapted to be supported and rapidly moved by the long and slender neck. Important differences are also found in the form and arrangement of the individual bones composing the skulls, but it will suffice on this occasion to mention that the Long-Necked Lizards differ from their short-necked contemporaries by the absence of a ring of bony plates within the eye-ball,* and also by the circumstance that their long and sharp teeth are implanted in distinct sockets, instead of being arranged in a continuous open groove. In the latter respect the creatures under consideration resemble crocodiles, and no other existing reptiles.

In the article on Fish-Lizards a woodcut (Fig. 3) of one of the joints of the back-bone, or vertebræ, shows that these are very short doubly-concave discs, and in the region of the back carry two small facets on their sides, with which the forked heads of the ribs are articulated. Moreover, the upper part of each vertebra, forming the arch through which the spinal marrow runs, is completely separated from the body of the vertebra (the only part shown in the figure), and takes no sort of share in supporting the ribs. If, however, we have the opportunity of examining one of the joints of the back-bone of a Long-Necked Lizard taken from the region of the back, we shall find a very different state of things. Thus, in the first place, the body of the vertebra, although still more or less cupped at both ends, in most cases is considerably longer, so as to form a cylinder rather than a disc. Then, again, the upper arch for the spinal marrow is generally more or less closely united with the body of the vertebra, so that the whole structure forms one piece. Moreover, the sides of the body are quite smooth, having no trace of facets for the support of the ribs. The latter are, indeed, attached to long horizontal processes jutting out at right angles from the sides of the arch, and thus precisely similar to those with which we are all familiar when carving a sirloin of beef at table. It will be obvious from the foregoing that if we look inside the cavity of the body of a Long-Necked Lizard, we should find that the whole of the bodies of the joints of the back-bone projected into the cavity; whereas it will be equally evident that in the Fish-Lizards only the lower part of such joints are so projected.

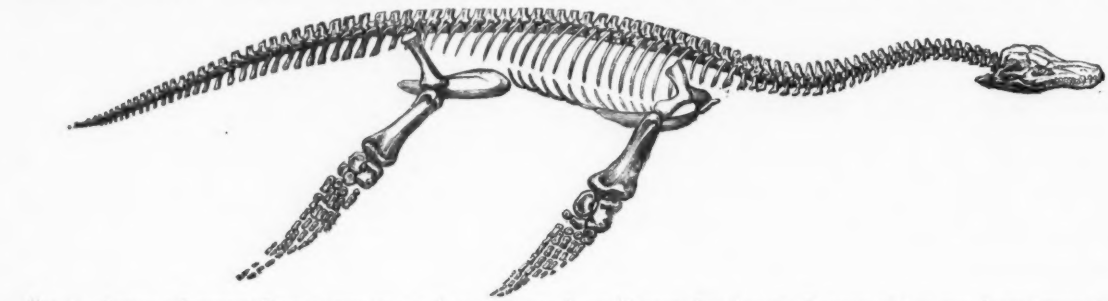


Fig. 1.—Greatly Reduced Restoration of the Skeleton of a Long-Necked Sea-Lizard (Plesiosaur) of the Dorsetshire Lias.

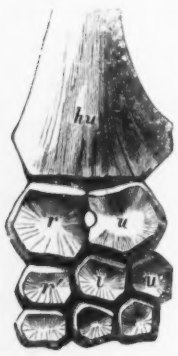


Fig. 2.—Part of the Fore Paddle of a Long-Necked Lizard. *hu*, lower half of arm-bone; *r*, *u*, bones of the fore-arm; *r' i u'*, upper row of wrist-bones.

In saying that the sides of the bodies of the vertebræ of the reptiles under consideration have no facets for ribs, the reader should bear in mind that this applies only to the region of the back, since the small ribs which are found in the necks of these creatures are articulated with the sides of the bodies of the vertebræ.

In the general structure of the back-bone and ribs the Long-Necked Lizards come nearer to crocodiles than to any other existing reptiles.

Such, then, are the chief features of the bony framework of these curious reptiles. The absence of any trace of bony plates, like those found in the skin of the crocodiles, leads to the conclusion that (in spite of the statement of the Babu) the bodies of the Long-Necked Lizards were clothed with a smooth skin like that of porpoises. In regard to the habits of the Plesiosaur, we cannot do better than quote the words of Mr. Conybeare, who says: "That it was aquatic, is evident from the form of its paddles; that it was marine is almost equally so, from the remains with which it is universally associated; that it may have occasionally visited the shore, the resemblance of its extremities to those of the turtle may lead us to conjecture; its motion must, however, have been very awkward on land; its long neck must have impeded its progress through the water; thus presenting a striking contrast to the organization which so admirably fits the Ichthyosaur [Fish-Lizard] to cut through the waves. May it not, therefore, be concluded (since, in addition to these circumstances, its respiration must have required frequent access to the air) that it swam upon or near the surface; arching back its long neck like the swan, and occasionally darting it down at the fish which happened to float within its reach? It may, perhaps, have lurked in shoal-water along the coast, concealed among the sea-weed; and, raising its nostrils to a level with the surface from a considerable depth, may have found a secure retreat from the assaults of dangerous enemies; while the length and flexibility of its neck may have compensated for the want of strength in its jaws, and its incapacity for swift motion through the water, by the suddenness and agility of the attack which they enabled it to make on every animal fitted for its prey which came within its reach."

Nothing that has been discovered since the date when the above passage was penned can suggest any more probable interpretation of the habits of these creatures.

The larger species found in the Lias attained a length of about 20 feet; but, as is so generally the case, we find the size of the species gradually increasing as we ascend

* Shown in Fig. 1 in the article on Fish-Lizards.

in the geological scale, the culmination being reached in the period of the chalk, when, both in Europe and North America, we meet with species reaching to the enormous length of 40 feet, and the joints of whose backbone measured as much as 6 inches in diameter. These terrible creatures must indeed have been dragons of the deep, with a far more strange appearance than any of those imagined in fable.

The general dimensions, although perhaps not the absolute length, of these monsters were, however, greatly exceeded by those of a closely allied group of marine reptiles whose remains occur in the Oxford and Kimeridge clays of the great Oölitic series of rocks. These creatures, which are known by the name of Pliosaurs, although agreeing with the Long-Necked Lizards in the structure of their paddles and backbone, differ very widely from them in having enormous heads, for the support of which a short and thick neck is, of course, absolutely essential. A skull of one of these giants found on the Dorsetshire coast and exhibited in the Natural History Museum, is nearly 6 feet in length; while a hind paddle in the same collection measures upwards of 6½ feet, of which no less than 37 inches is taken up by the thigh-bone alone. The enormous biting power and destructive habits of these creatures is evidenced by their teeth, which are not unfrequently found in the Kimeridge clay, and one specimen of which is upwards of a foot in length from the tip of the crown to the base of the root. These teeth are readily distinguished from those of all other reptiles, not only by their huge size, but also by the triangular form assumed by their crowns; one surface of the triangle being usually nearly smooth, while the other two are ornamented with vertical ridges.

We may pretty safely assume that in the ancient seas of the Oölitic period the Pliosaurs acted the same part as is played by the ferocious Grampuses or Killer-Whales in those of the present day.

Turning from these latest modifications into which the Long-Necked Lizards were finally developed, and looking back at the earliest known representatives of the group, we find in the strata lying below the Lias, and thus forming the very base of the secondary rock-series, the remains of a number of more or less closely allied forms, the largest of which did not exceed a yard in length. These small reptiles were evidently ancestral types of the larger species found in the Lias, but they exhibit certain structural features clearly indicating that they were in great part of terrestrial or fresh-water habits, and their whole organisation departs less widely from the general reptilian type than is the case with their successors in time. Thus we reach the conclusion that the Long-Necked Lizards, like the Fish-Lizards, were in all probability descended from small land reptiles, and have been gradually more and more modified for the exigencies of a purely marine life. In this respect, therefore, these ancient creatures present a precise analogy to the Whales and Porpoises of to-day, which, as Professor Flower has so clearly shown, there is every reason to regard as having taken their origin from terrestrial mammals.

PROFESSORS LIVEING AND DEWAR, in a paper recently read before the Royal Society, show that fine dust suspended in gas does not become luminous with its characteristic spectrum in an electric discharge, and they conclude that if the spectrum of the Aurora is due to adventitious matter from planetary space, rather than to the ordinary constituents of the atmosphere, such matter must be brought into the gaseous state before it can become luminous in an electric discharge.

WHAT IS A HAZE?

BY DR. J. G. MCPHERSON, F.R.S.E. (*Lecturer on Meteorology in the University of St. Andrew's*).

TILL very recently, meteorologists were not certain how to account for the varied phenomena of the cloud-world. The haze so familiar in summer, the fogs of winter, the drizzling mists, and thin rain, as well as the great thunder-rain, and hail, and the feathery snow, are now all believed by physicists to be intimately connected with the dust-particles in the air, on which the water-vapour settles, and forms, under different circumstances, the varied phenomena referred to.

According to Mr. Aitken, whose investigations have been recently laid before the Royal Society of Edinburgh, haze is generally only an arrested form of condensation of water-vapour. Cloudy condensation is changed to haze by the reduction of its humidity. To explain this he invented a simple apparatus for testing the condensing power of dust, and observing if water-vapour condensed on the deposited dust in unsaturated air.

He had first to collect the dust from the air. If inside a room, he placed a glass plate vertically and in close contact with one of the panes of glass in the window, by means of a little india-rubber solution. The plate being thus rendered colder than the air in the room, the dust was deposited on it. If the experiment was to be made on the air outside, the glass plate was kept at a distance from the pane by means of small pieces of sheet india-rubber at the corners of the plate. In this way the air circulated in the space between the plate and the window, and as this air, heated on the window pane, became warmer than the plate, the dust was attracted to and deposited on the cold surface of the outer plate.

Having thus obtained on the plate the particles of dust from the air, he set himself to test the condensing power of the dust, for which purpose he constructed a rectangular box, with a square bottom, 1½ in. a side and ¾ in. deep, and open at the top. The top edge of the box was covered with a thickness of india-rubber. The dusty plate—a square glass mirror 4 inches a side—was placed on the top of the india-rubber and held down by spring catches, so as to make the box water-tight. The box had been provided with two pipes, one for taking in water and the other for taking away the overflow, with the bulb of a thermometer in the centre. The dust was carefully cleaned off one half of the mirror, so that one half of the glass covering the box was clean and the other half was dusty. He poured cold water through the pipe into the box, so as to lower the temperature of the mirror, and carefully observed when condensation began on the clean part and on the dusty part, and took a note of the difference of temperature. By this experiment he estimated the condensing power of the dust. As the condensation of the water-vapour appeared on the dust-particles before coming down to the natural dew-point temperature of the clean glass, the difference between the two temperatures indicated the temperature above the dew-point at which the dust condensed the water-vapour.

Taking special kinds of dust, he brought out marked differences in their condensing power. Magnesia dust has small affinity for water-vapour; accordingly he found that it condensed at almost exactly the same temperature as the glass. Gunpowder has great condensing power. All have noticed that the smoke from exploded gunpowder is far more dense in damp than in dry weather. Accordingly, in the experiment, he found that the dust from gunpowder smoke began to show signs of condensing the vapour at a temperature of 9° Fahr. above the dew-point. In the case

XUM

of sodium dust, it condensed vapour from air at a temperature 30° above the dew-point.

He then examined the condensing power of dust in different specimens of air. Dust collected in a smoking-room showed a decidedly greater condensing power than that from the outer air. The condensing power of the dust in the air of the smoking-room varied from 4° to 8° above the dew-point; whereas that of the outer air varied from 3° to 5½°. Strange to say, he found that the depth of the deposited dust had no visible influence on the condensing power of the dust, as the amount of dust that was deposited on the mirror in one day gave an equal thermometric difference with that which had been collected for a fortnight.

We can now understand why the glass in picture frames, and other places, sometimes appears damp when the air is not saturated. When in winter the windows are not often cleaned, a damp deposit may be frequently seen on the glass. Anyone can try the experiment. Clean one half of a dusty pane of glass in cold weather, and the clean part will remain undewed and clear, while the dusty part is damp to the eye and greasy to the touch.

These observations indicate that moisture is deposited on the dust-particles of air which is not saturated, and that the condensation takes place while the air is comparatively dry, before the temperature is lowered to the dew-point. There is, then, no definite demarcation between what seems to us clear air and thick haze. The clearest air has some haze, and, as the humidity increases, the thickness of the air increases. But from what we consider clear air to haze there is no real difference in kind, but only in the amount of the thickening. In all haze the temperature is above the dew-point. The dust-particles are saturated with the moisture so as to form haze, before the fuller condensation takes place at the dew-point. At the Italian lakes on many occasions, when the air was damp and still, he observed in close proximity every stage of condensation, not separated by a hard and fast line, but when no one could determine where the thick air ended and the cloudy began. Sometimes in the sky overhead we observe a gradual change from perfect clearness to thick air and then to cloud.

Mr. Aitken concluded that the dust in our atmosphere has in almost all degrees of humidity more or less water attached to it. A thick haze may be occasioned by an increased number of dust-particles, with little moisture, or of a diminished number of dust-particles with much moisture, above the point of saturation. The haze is cleared by the temperature rising so as to allow the moisture to evaporate from the dust-particles.

By a series of observations, he found that whenever the air was dry and hazy there was much dust in it, and that as the dust decreased the haze also decreased. For example, at Kingairloch, in one of the clearest districts of Argyleshire, on a clear July afternoon, he counted 4,000 dust-particles in a cubic inch of the air; whereas, two days before, in a thick haze, he counted no fewer than 64,000 in the cubic inch. At Dumfries the number counted on a very hazy day in October increased twenty-fold over the number counted the day before when it was clear.

All know that thick haze is usual in very sultry weather. During the intense heat there is generally much dust in the atmosphere; this dust, by the high temperature, attracts moisture from the apparently dry air, though above saturation-point. In all circumstances then, the haze can be accounted for by the condensing power of the dust-particles in the atmosphere, at a higher temperature than that required for the formation of fogs, or mists, or rain.

INSECTIVOROUS PLANTS.

By J. Pentland Smith, M.A., B.Sc.

A PLANT normally receives its food from two sources, from the air by means of the leaves, and from the soil by means of the roots; and some forms of plants have an additional means of nutrition, which we will proceed to discuss.

Amongst the *Sphagnum* or Moss of our bogs there grows a pretty little plant known as the Sundew or *Drosera rotundifolia*. It has a small root that lies buried amongst the moss, and resting on the moss surface there is a reddish rosette of club-shaped leaves (Fig. I., *c*). The blade of each leaf is covered on the upper surface with innumerable "tentacles," which are also club-shaped. The club or head (Fig. I., *d*, *g*) is generally surrounded with a honey-like secretion, which glistens in the sunshine and obtains for the plant its common name of the Sundew. Its botanical name Drosera has the same signification, being derived from the Greek δροσερος, "dewy." During the summer it sends up a flowering stem into the air, and produces seeds like an ordinary plant.

At times the tentacles on the blade of a leaf are seen to be curled up round an object which on closer examination generally turns out to be an insect in a state of semi-decomposition; its horny coat may alone be left to tell its fate. That such a curious occurrence was not uncommon came to the knowledge of Darwin, and he at once proceeded to make a series of elaborate experiments on these plants. He has chronicled, in his classical monograph on Insectivorous Plants, the results of his investigations which were continued for many years. Two hundred and twenty-three pages of this book are occupied with a description of the Sundew, and he finishes his description by quietly remarking, "I have now given a brief recapitulation of the chief points observed by me with respect to the structure, movements, constitution, and habits of *Drosera rotundifolia*; and we see how little has been made out in comparison with what remains unexplained and unknown."

We can only, in the limits of this paper, touch briefly on a few of the most interesting and suggestive points in the life of a Sundew.

The structure of the tentacles is detailed in the description of the Figure. The action of these is both curious and interesting. The material secreted by the glands possesses, it may be, some attraction for insects; at any rate, when these have once alighted there they do not find it an easy matter to relieve themselves from their grasp. The secretion is extremely viscid, and may be drawn out into long fine threads. The insect or prisoner, in its struggles to escape, touches the glands of the neighbouring tentacles, thereby bringing itself into closer relations with its foe, and the resultant irritation causes the tentacles to bend down, and the imprisoned insect is carried, or rather rolled, over by the tentacles to the centre of the leaf. The inflection of a tentacle does not take place immediately below the gland, but at the base of the filament, while the gland alone is sensitive to contact; from it the bending influence is transmitted to the base of the filament, though the filament itself is not irritable. The tentacles are so arranged that in complete inflection the outermost row is brought over the inner ones, by which means the glands of all are carried together to the centre of the leaf. The leaf may even become inflected like a cup.

But insects are only one of the inducers of this curious phenomenon. There are many other objects which have a like effect. Materials of such diverse character as bits of meat, moss, sponge, and glass, when placed on the leaves, cause the tentacles immediately to become inflected,

XUM

all these being ultimately embraced by them. "Their extreme sensibility to contact is truly wonderful. Two particles of the thinner end of a woman's hair, one of these being $\frac{18}{1000}$ of an inch in length, and weighing $\frac{1}{357\,14}$ of a grain, the other $\frac{19}{1000}$ of an inch in length, and weighing of course a little more, were placed on two glands on opposite sides of the same leaf, and these two tentacles were inflected half-way towards the centre in one hour ten minutes; all the other tentacles around the same leaf remaining motionless." "The smallest particle which was tried, and which acted plainly, was only $\frac{8}{1000}$ of an inch (·203 millemeter) in length, and weighed $\frac{1}{78740}$ of a grain, or ·000822 milligram."*

And yet the tentacles do not appear to be sensitive to heavy objects, such as drops of water or of mercury, Their surface is so perfectly homogeneous as to press *equally* on adjacent parts of the gland, and so obviate irritation.

Besides being sensitive to the contact of solid bodies such as we have described, the tentacles exhibit marked inflection when subjected to the action of certain fluids, those which have the greatest influence being such as contain in solution salts of nitrogen. This leads us to remark on another property possessed by the glands of Drosera, namely, that of *absorption*. They are capable of receiving into their interior certain fluids, and they appear, as regards this, to have a selective power. Various organic salts have been placed on their leaves. Those which contained no nitrogen did not cause inflection of the tentacles, while those which did caused inflection in a very marked degree. Now, nitrogen is one of the chief

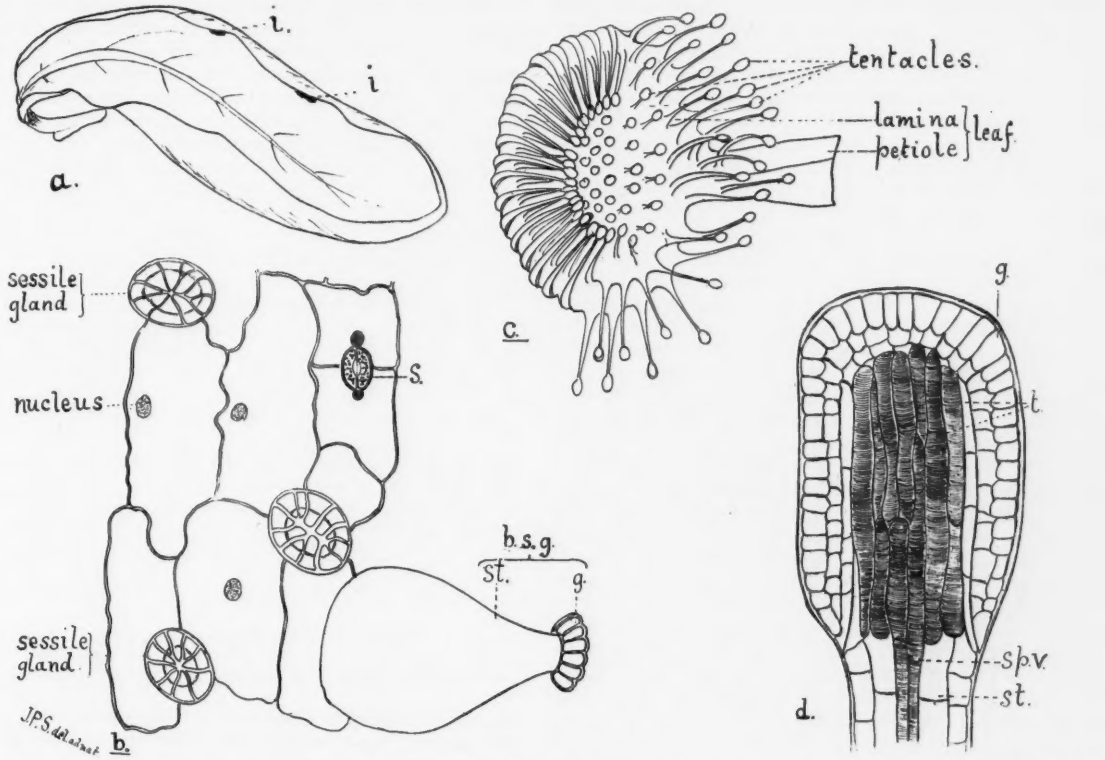


Fig. I.—*a*. Leaf of *Pinguicula vulgaris*, the Butterwort, less than natural size; *i*, insects caught by the leaf and almost covered by its incurved margin. *b*. Epidermis of upper surface of above, much magnified; *s*, stoma; *b s g*, bottle-shaped gland; *st*, its stalk; *g*, gland. *c*. Leaf of *Drosera rotundifolia*, enlarged. *d*. Tentacle of above; *g*, gland; *st*, portion of stalk; *t*, trachëides, that is, cells with spiral thickenings; *sp v*, spiral vessels.

or to a single sharp touch. This is a provision of Nature of great value to the plant, for, otherwise, during a shower of rain they would close up, and so be unable to obtain their prey. Darwin did not give a satisfactory solution of this remarkable circumstance, and it was not until after the publication of his work that the true reason was discovered. No object causes inflection of the tentacles until it has sunk through the viscid secretion, and come into direct contact with the gland. *On account of the unequal pressure on neighbouring parts* of the glands produced by any *solid* body, be it ever so light, such irritation is set up as to stimulate the tentacles to inflect. This explains at once why drops of water or mercury, although heavy bodies, have not the stimulating influence.

* Darwin's "Insectivorous Plants," page 25.

elements of plant food, and the one which plants obtain from the soil by means of the roots. But the roots of Drosera are very poorly developed and are embedded in moss, where there is but small chance of a nitrogen supply.

The power possessed by inorganic salts to cause the tentacles to bend varies in a marked degree. Salts of ammonia* in all cases act markedly, nitrogen being one of the elements composing these salts. Indeed, so sensitive are these glands that even the absorption of

* Ammonia, which proceeds from decaying animal and vegetable matter, and which can be easily produced by burning a piece of the finger-nail in the flame of a candle, has a composition NH_3, that is, one atom of nitrogen is combined with three atoms of hydrogen to form one molecule of ammonia; in other words, fourteen parts by weight of nitrogen unite with three parts by weight of hydrogen to form seventeen parts by weight of ammonia.

XUM

one twenty-millionth of a grain of ammonium phosphate causes inflection of the tentacles.

When an object is placed on one or more of the glands on the centre of the disc, the corresponding tentacles do not inflect, but they seem to transmit an influence to the glands on the edge of the disc which causes them to secrete more copiously, and to send an influence down their tentacles such that inflection of the stalk results. The secretion poured forth at this time has an acid reaction, that is, it turns blue litmus paper red, whereas in the unexcited state it has not an acid reaction. Moreover, it possesses the property of rendering soluble organic bodies, termed proteids (compounds of carbon, hydrogen, oxygen, and nitrogen), in other words, of digesting them. The tentacles remain inflected for a much longer period over such bodies than they do over substances which can afford them no nourishment. We can again see the use of this wonderful mechanism of which we have been speaking. Owing to the manner of inflection of the tentacles, the food is carried to the centre of the leaf-blade, where it may come in contact with all the glands, and so be bathed in their digestive secretions.

In this secretion there is a ferment, which, on addition of an acid, has digestive power. (A ferment is a substance which is capable of digesting other substances, while it remains unchanged itself.) According to Darwin the ferment is not secreted until the glands have absorbed some nitrogenous material; but later authorities hold that it is the acid which is absent, not the ferment. The walls of the stomach of an animal pour forth a peptic secretion from their glands in which the acid—hydrochloric acid—is not present unless the glands have been mechanically excited. The ferment there present is pepsin. It changes the nitrogenous compounds into peptones, but is unable to act on carbo-hydrates,* as sugar and starch, and in this point agrees with Drosera. We might thus be justified in comparing the leaf-blade and tentacles of Drosera with the stomach of an animal, were it not that lately the view has been advanced that the gastric juice of the stomach has no digestive power until mechanically irritated, not because of the absence of a ferment, but on account of an acid not being present. It is most interesting to notice how small pieces of meat, raw or boiled, &c., gradually undergo digestion when placed on the tentacles of this curious plant. First, their angles get rubbed down, then the whole mass visibly decreases in volume, and soon disappears. Even such unlikely subjects as bone and enamel of teeth are slowly but surely attacked by the peptic secretion, and finally completely digested. The time occupied in digestion varies with the subject in hand, its nature, solubility, and size. The tentacles may remain clasped over these for a period varying from one to seven days.

Dionæa muscipula, Venus's Fly Trap, belongs to the same Natural Order (*Droseraceæ*) as the Sundew. It is not a native of this country. North and South Carolina are the only parts of the world in which it is known to grow wild. Its roots, like those of Drosera, are very small, and probably serve only as absorbers of water. The leaves (Fig. II.) are diagnostic in their appearance. They are generally about $1\frac{1}{2}$ inch in length. The leaf-stalk or petiole is winged, and the blade or lamina is bi-lobed; a very firm midrib connects the lobes. The margin of each lobe is furnished with teeth, and the upper surface of each presents three pointed hairs (Fig. II.), and in addition innumerable glands. These last impart a reddish tinge to the leaf. The teeth are so arranged that when the two lobes come together they interlock like the fingers of the clasped hands. The six bristles are extremely sensitive to contact. In a healthy plant a mere touch suffices to cause the immediate closure of the two halves of the leaf. Their base exhibits a bulbous enlargement, beneath which is a joint fastening them to the leaf. This mechanism enables them to fold up against their respective lobes, and so prevents them being injured when the leaf closes.

Normally the leaf-surface is perfectly dry, but whenever a body containing soluble nitrogenous material is placed on them the glands commence to secrete freely. Substances devoid of nitrogen have not the power of inducing secretion. Should such be clasped by the leaf, owing to the irritation of the sensitive hairs the leaf very soon opens and exhibits a dry surface. The secretion, like that of the Drosera, contains an acid and a ferment, and has similar powers of digestion. An animal like a wood-louse, for instance, can be completely digested in four days. During this period the lobes of the leaf are so tightly closed round the unfortunate animal as to show the outline of its body on their exterior, and the glands

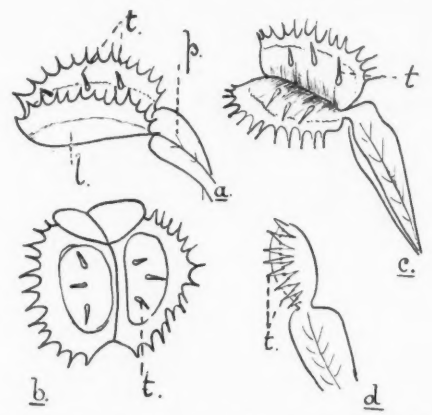


Fig. II.—Leaves of *Dionæa muscipula*.—*a*, partly opened; *b*, fully opened, front view; *c*, almost fully expanded; *d*, tightly closed; *t*, sensitive hairs; *p*, petiole; *l*, lamina.

secrete so freely as to bathe it in a slimy mass, which drops continuously from between the lobes should a portion of the base or apex of one of these be cut away.

Remarkable provisions have been made by Nature whereby the plant may not be uselessly put to the expense of closing its leaf-lobes. As in Drosera, rain and winds have no effect on the sensitive hairs; probably, as in that plant, only irritation of adjacent parts is the cause of the exhibition of sensitiveness. These hairs are, however, much more sensitive to a slight touch than the tentacles of Drosera. Only after repeated touches do the tentacles of that plant exhibit an inclination to inflect, but the slightest touch with a small piece of ordinary cotton thread is enough to cause the lobes of Dionæa to be approximated. The value of this is quite evident. In Drosera there is a viscid secretion awaiting the arrival of the unwary prey; in Dionæa there would be no means of preventing an animal leaving a leaf immediately it had alighted thereon, were it not for the exquisite sensitiveness of the hairs which it is almost bound to touch.

Dr. Burdon Sanderson has made the wonderful discovery "that there exists a normal electrical current in

* Carbo-hydrates are compounds of carbon, hydrogen, and oxygen, in which the hydrogen and oxygen are present in the same proportion as they are in water (H_2O), that is, there are always two atoms of hydrogen to every atom of oxygen.

the blade and foot-stalk; and that when the leaves are irritated, the current is distributed in the same manner as takes place during the contraction of the muscle of an animal."

No less interesting a plant is the Butterwort (*Pinguicula vulgaris*). It is found growing in moist situations in many parts of Great Britain. Its leaves (Fig. I., *a*) appear as a rosette above ground, like those of the preceding. They are, as a rule, two inches in length. From the centre of the rosette ascends into the air a flowering stem bearing two or three small blue flowers on its summit.

The upper surface of the leaves is studded with innumerable glandular bodies (Fig. I., *b*), some of which are sessile, that is, arise immediately on the leaf-surface, while others are supported on a more or less elongated, flask-shaped stalk, and so may be conveniently termed bottle-shaped glands. From all a secretion exudes which is extremely *buttery*, hence the name of the plant; and so viscid that it holds fast any insect that may alight on it. The struggles of the insect to free itself only lead, as in the case of Drosera, to its closer entanglement, in consequence of the greater surface of fluid with which it comes into contact.

The mechanism of this plant is very much simpler than that of the foregoing. The margin of the leaf curls inwards *lengthwise*, and so grasps its prey. The secretion is peptic. Non-nitrogenous substances cause the glands to secrete freely; but the secretion is not acid. On the other hand, the secretion due to contact with nitrogenous substances gives an acid reaction, and has the property of dissolving proteid compounds. Vegetable objects, such as pollen grains, are often digested; this, by-the-bye, also occurs in Drosera. These plants, then, might well be termed herbivorous and carnivorous, as well as insectivorous.

Drosera, Dionæa, and Pinguicula can flourish without the addition of nitrogenous material derived from the capture of animals; but it has been found that plants so nourished exhibit more vigorous growth and are capable of producing a greater number of seeds than their non-carnivorous neighbours.

(To be continued.)

ON THE CONSERVATION OF ENERGY.—II.

By J. J. Stewart, Cavendish Laboratory, Cambridge; *late Demonstrator of Physics at University College, London.*

(*Continued from page* 233.)

ONE of the most important forces of nature is *gravitation*, by which every particle of matter in the universe attracts every other particle with a force which varies directly with the mass of the two attracting particles, and inversely with the square of the distance between them. The cause of this attraction is unknown, but we can observe the effects of it in increasing the energy possessed by a given mass of matter. Thus a pail of water carried to the top of a hill has more energy than it had at the foot. Its internal physical state may be exactly the same, but it has now "energy of position." It is the same energy of position which is made use of in the case of the mill-pond, and it was energy of position which gave an advantage to the defenders of the ancient hill-forts we see scattered over our country; their missiles were actually worth more than those of the assailants on the lower ground, they required less work to be expended upon them, having an additional quantity of energy which was given to them when work was done upon them in carrying them up. The difference between the invaders who had laboriously to throw their darts up hill, and their enemy above them, is obvious.

The force of *elasticity* is that which comes into play when a bow or spring is bent. Its potential energy in its constrained position disappears when the bow is released; but part of it can be utilised in giving energy of visible motion to the arrow. *Cohesion* is the force which acts between molecules of matter in close contact and binds them together. When they are forced further apart, as by the action of heat causing expansion, the energy of the heat thus spent is stored up as energy of position—a tendency in the particles to approach together which they do on cooling. This is made use of in the method sometimes employed to straighten the walls of a building which have begun to bulge. A heated bar of iron is fixed at its opposite ends to the walls, and the forces brought into play when it contracts on cooling are sufficient to pull the walls into position. A great store of potential energy is that due to *chemical affinity*—the tendency which separated atoms having an attraction for each other have to combine. This force, which goes by the name of *chemical* affinity, may itself be due to the dynamical relations of the atoms of matter in elements or compounds, as recently suggested in a remarkable paper by Professor Mendeleef, of St. Petersburg. The change of this force, whatever it is, into heat is familiar in combustion when the carbon of fuel unites with the oxygen of the air. The chemical combination only takes place when the contact of the atoms is very close. The force of affinity is very powerful, but acts only at very short distances.

A very important form of energy is that associated with electricity. Electric force is called into play when dissimilar bodies, such as silk and glass, or flannel and sealing-wax, are rubbed together; and its presence is shown by the attractions and repulsions which electrified bodies exert. We may say that the force exerted in attraction, in the case of statical electricity, is due to the energy of electrical separation, and this is partly changed into energy of motion when the bodies under its influence approach each other in obedience to this attraction. Frictional electrical machines are used for producing the statical electricity, or electricity at rest; and it is found that it is more difficult to turn the handle of the machine when it is working and producing the separation of positive and negative electricity than when none is being generated. The extra mechanical work expended appears in its equivalent of electrical energy.

Electric force is generally employed in the form of current electricity, or electricity in motion. This form may be produced by means of the voltaic battery. The battery of Grove consists of a series of cells; each of these is made up of two vessels, an outer one filled with dilute sulphuric acid, in which a plate of zinc is placed, and, inside this, one made of porous earthenware and containing nitric acid, in which is a strip of platinum. The platinum-plate of each cell is connected with the zinc of the next, and wires are joined to the plate of zinc at one extremity of the battery and the plate of platinum at the other. When the platinum and zinc of such a cell or the end plates of a series of cells are connected by a wire a current of electricity flows through the arrangement. What occurs is often expressed thus: Positive electricity passes from the zinc to the platinum through the liquids of the cell, and back from the platinum to the zinc through the wire. That a battery such as this possesses a store of energy is shown by the effects which it can produce. If the ends of a fine wire are joined to the poles of a battery, the current which will pass through will cause it to be

XUM

heated, and when the current passes through conductors these become capable of deflecting magnetic needles, and, if coiled round a core of soft iron, can be made to form an electro-magnet.

The effects classed together under the name of induction are a remarkable example of the transmutation of energy. When a coil of wire in which a current is flowing is moved up towards a second coil, a current is produced in the secondary coil which lasts while the motion of the first coil continues, and is in the opposite direction to the current in the first. Now, it is known that currents flowing in two parallel wires repel one another if the directions through the wires are opposite. In the case of the induced currents of the two coils the directions are opposite, and experiment shows that the motion of the first coil is retarded. Here we have the production of electrical energy in the current in the second coil, and at the same time energy of motion is destroyed; the law of conservation is therefore seen to hold good. Similarly, when a coil with a current flowing round it is moved *away from* another coil, a current in the *same* direction is produced in the secondary; and as currents in the same direction attract one another, the movement apart of the two coils is checked, and, as before, energy of motion disappears, taking the electrical form. A beautiful experiment is that of rotating a copper disc or coil of wire between the poles of a powerful magnet. If left to itself it will quickly come to rest, currents being produced in it which are attracted by the magnet; but if its motion is forcibly kept up, resistance will be felt to its turning, and the copper will soon become hot. It is to induced currents of this sort that recourse is had to produce the electric light. Coils of wire are made to rotate at a great speed between the poles of powerful electro-magnets, and the currents induced in them are led away to pass through the electric lamp.

The various forms of energy have been classified thus:—1. Energy of visible motion. 2. Visible energy of position. 3. Heat motion. 4. Molecular separation. 5. Chemical separation. 6. Electrical separation. 7. Electricity in motion. 8. Radiant energy, which is the form in which energy comes from the sun to the earth. Now if we imagine a portion of the physical universe to be cut off from all communication with the rest, so that no energy can enter it or leave it, then the principle of the conservation of energy says that the energy of that isolated portion will remain for ever constant; the various sorts of energy which make up the total quantity may be constantly changing from one form into another, mechanical motion passing into heat, heat into electrical energy, and so on, but as a whole the energy remains the same. If, instead of an isolated portion of the universe, we take the whole of it into account, this principle asserts that the energy of the universe remains constant in amount though ever varying in form and manifestation. The truth of this cannot be proved in a direct manner, for we cannot fix a portion of energy and prevent its passage; but assuming the principle to be true, certain consequences follow, and these can be put to the proof by experiment. Thus it follows, from the law of conservation as exemplified in the theory of thermo-dynamics, that the freezing point of water should be lowered by pressure. This was first pointed out by Dr. James Thomson, and when some time after his brother, Sir William Thomson, put the theory to the test of experiment, it was found to be verified, the temperature at which water froze became lower when the pressure was increased. Similarly, reasoning founded on the principle of conservation shows that a substance which contracts when heated will be cooled by compression. Now water for some degrees above freezing point gets less in bulk when heated, and it has been shown by Dr. Joule, in a series of delicate experiments, that at these temperatures compression causes it to become colder. At higher temperatures at which water expands on heating, its temperature is raised by an increase of pressure. Like results have been got with other substances, whose volume becomes less on the application of heat. There are numerous cases in which deductions from the law of conservation can be tested experimentally, and it is found that they are invariably confirmed. This affords as thorough a proof as the nature of the case admits of, and one which is ever becoming strengthened as our knowledge increases.

Assuming then the truth of the great principle of conservation, let us consider a few of the transmutations which the various forms of energy undergo. The change of the energy of visible motion into heat takes place in all cases of friction, and is well exemplified when iron is hammered on the anvil until it is red hot. The vibratory motion of a sounding body, such as a bell, gradually ceases, the motion changing into heat, which is the form which all sorts of visible motion tends to take. In the steam-engine, a part of the heat in the steam passes entirely out of existence as heat, to appear in the form of mechanical work. This change of heat into work can only take place as the heat passes from a substance of high temperature to one of lower, and in all actual engines a great portion of this heat cannot be changed into work at all. When heat is applied to produce steam from boiling water, a large quantity is absorbed, though the steam is no hotter than the water from which it is formed. Here the heat is changed into potential energy, and is used up in pulling asunder the molecules against the force of cohesion. When certain crystals, such as tourmaline, are heated, they become electrified—one end becomes positive, and the other negative. Some of the heat has passed into the form of energy of electrical separation. This is a comparatively rare phenomenon; a much commoner one is the direct transformation of heat into the energy of the electric current. If an iron wire be joined at its ends to the extremities of a copper wire, so as to form a closed circuit, and one of the junctions of iron and copper be heated whilst the other is kept cold, a current of electricity will be produced, flowing from the copper to the iron through the hot junction. [Similar effects are got with circuits of other metals.] If the other junction is heated as the metals are there arranged in the opposite order, a reverse current arises. If this junction is cooled, a current in the same direction as the first, and strengthening it, is produced. Peltier discovered that if a current was sent through a junction of different metals, in the same direction as the current the heating of the junction would produce, the junction was cooled; if in the opposite direction, it was heated; the effect depending on the direction of the current. Now this is what the law of the conservation of energy requires should hold true for such a circuit. Peltier's discovery was made before the principle we are considering was developed, and before there was any expectation that such a phenomenon would occur. Heat is carried, as it were, in this case, from the hotter to the colder parts of the circuit.

The potential energy due to chemical separation is changed into heat in the case of combustion, or into the energy of the electric current when separated elements such as zinc and oxygen unite together in the voltaic battery. In the latter case, the electrical energy produced from what may be called the chemical form becomes transformed into heat when the current heats the wire through which it passes.

XUM

One of the methods employed by Joule in determining the mechanical equivalent of heat depended on this production of heat when an electric current overcomes the "resistance" of a wire to its passage, and the results he obtained coincided with those mentioned above, which were got by frictional production of heat. Heat is produced by the chemical action which takes place when zinc is dissolved in sulphuric acid. The same amount of heat is generated if this chemical action first produces an electric current, which is entirely used up in heating a wire through which it flows.

The potential energy of two electrified bodies changes into that of visible motion when, owing to their attraction they approach each other, and when a spark passes between such bodies as in the discharge of a Leyden jar, their energy takes the form of a current of electricity, and ultimately that of heat. The powerful nature of this store of energy is seen in the thunderstorm, but by the time the lightning-flash is seen the electric energy has gone; it has then taken the form of heat, the flash being due to intensely-heated particles of air or dust.

The sun is the principal storehouse or reservoir from which the energy on our earth is drawn, and it has been suggested that the vast supply of energy which he possesses on account of his exceedingly high temperature has arisen from the gravitating together of particles of matter; whilst the sun condensed from a nebulous state, in which its present constituents were spread out at immense distances apart. A remarkable question is what becomes of the energy given forth from all parts of the sun's surface, and which never comes in contact with the planets or stars. The greater part of the radiant energy poured out from the sun never reaches these, and, so far as our knowledge extends, there seems no other alternative than to suppose that this energy, given out ages ago from the sun, is still travelling outwards through space with the velocity of light, that of 184,000 miles per second. In considering the forces of nature we constantly come across mysteries which are quite beyond our comprehension.

The radiant energy which reaches us from the sun is converted into absorbed heat when it falls on opaque substances, causing them to become hot. It is also transformed into the potential energy of chemical separation as when it separates the carbon from the oxygen of carbonic acid in the leaves of plants. Through the agency of the growing plant energy is stored up in its structure, as the potential energy of chemical affinity, and in the act of combustion or re-combination of the carbon with the oxygen, runs down as it were, or is changed into the form we call heat. The potential energy of a head of water is really derived from work done upon it by the sun in its being lifted up to a higher level by evaporation. So in its descent it may be caused to turn a water-wheel, and this energy of motion may be either used on the spot, or, being changed into the electrical form by a dynamo machine, carried away through a wire to drive an electric motor at a distance, or transformed into heat and light in an electric light installation. Energy in the form of mechanical work, or in that of chemical affinity—*i.e.* the tendency of separated elements to unite with each other—is made to appear as electric energy in the currents which pass from the dynamo-electric machines or secondary batteries, these currents being themselves transmuted into the light-producing vibrations which emanate from the electric lamp. Again, the mechanical energy of the steam-engine which drives the dynamo machine has been itself transformed from that of heat, which was produced by the combustion of fuel, this again having received its energy, perhaps ages before, from the sun.

It is needless to multiply examples; energy, in all the transformations of which it is susceptible, never disappears. No doubt it tends to become less available to man by its tendency in all his machines to be changed (as by friction) into heat of a low temperature. This peculiarity of energy, viz. its tendency to take one particular form, that of heat, has been embodied in one general law by Sir William Thomson, under the name of the dissipation of energy. Heated bodies, as is well known, if they are of different temperatures, reach, when placed in contact, one common intermediate temperature, the hot ones parting with some of their heat to the colder ones, which are thereby made hotter. This diffusive property of heat is ever tending to lessen the amount of available work which we can get out of heated matter to drive our machines, for the amount of work which can be got from any arrangement of heated bodies depends on their difference of temperature; this is seen in the case of the steam-engine with its boiler and condenser. When mechanical work is converted into heat, only part of this heat can be changed back again into work. Now, as the energy in the visible universe is known to be constantly passing into this degraded form of uniformly distributed heat, it follows that the amount which remains available, that is, capable of changing into other forms and "doing work," is ever getting less and less. This "degradation" of energy takes place whenever mechanical motion is changed into heat by friction, whenever a current of electricity in passing along a wire heats it, and no movement takes place without a certain portion of the energy displayed thus becoming changed into heat. The only conclusion which can be drawn from this universal law of dissipation is that the universe, as we at present see it, cannot be permanent. The powerful and unceasing changes going on within it, must surely, though gradually, come to an end. The condition to which it is at present tending seems to be that of changeless uniformity, in which no energy, whether in the form of visible motion or in that unseen motion of the particles of bodies called heat, can pass from one portion of matter to another. Of course it is impossible that any vegetable or animal life can exist under these conditions; but this final state of a dead universe, if it ever come to pass, must be immensely distant in the future.

IS THE MOON COVERED WITH ICE?

By A. C. RANYARD.

IF the lunar maria were covered with water, or if they were covered with a smooth surface of ice, we should expect to see a brilliant patch of sunlight reflected from them at certain times in the lunar month when the maria occupy a position half-way between the apparent centre of the moon's disc and the place where the sun's rays are falling vertically on the lunar globe; but no patch of light giving evidence of even a small degree of specular reflection from the moon's surface has ever been observed, though the region over which such a patch would travel passes over several maria and over many ring mountains which have by some theorists been supposed to be ice-lakes melted and evaporated by the moon's volcanic or internal heat.

We may therefore conclude with some degree of certainty that there is no extensive area of water or smooth ice surface on the moon, at all events in the neighbourhood of the lunar equator, which is the region of all others where we should expect to find areas of water if they existed. In a former paper (KNOWLEDGE, May 1890), I called attention to the fact that there is no marked difference in the colour or whiteness of the lunar equatorial and polar regions indi-

XUM

cating the existence of polar caps of ice and snow, such as we see growing and waning with winter and summer on the poles of Mars. We are therefore driven to assume either that there are no snow-fields upon the moon, or that the polar caps of ice and snow have advanced and coalesced at the lunar equator. The latter of these suppositions seems to me the more probable of the two, even though the *albedo* or light-reflecting power of the moon's surface taken as a whole is, according to Zolner, only 0·1736, while the *albedo* of clean snow is 0·783; that is, the moon reflects only about a fourth of the light that it would reflect if it presented a uniform surface of purely white snow.

There is great variety in the light-reflecting power of different parts of the moon—all the great planes and most of the low-lying land seem to be comparatively dark, while the higher land and mountain-tops are relatively white. This is proved not only by direct observation of the maria and mountains on the part of the moon's surface turned towards us, but also by the narrow band of increased whiteness* lying along the limb or outer smooth edge of the moon, where only the tops of the mountains are seen in projection, and all the lower lying land is hidden from sight. If there were no ice and snow upon the moon, we should be forced to assume that the mountain-tops were all of a different and whiter material than the lower lying land, which would involve very curious geological assumptions; or we should have to assume that the mountain-tops have all been bleached, so as to be whiter than chalk, by some curious chemical or physical action which has not affected the rocks lying at lower levels. It seems easier to assume, according to terrestrial analogies, that the whiter surface is covered with snow and ice, and that the lower lying regions either exhibit the true colour of the lunar soil or are covered by ice discoloured by the material brought down by glaciers and drainage.

Some light may be thrown upon the lunar conditions by considering what takes place on the earth, in mountainous regions above the level of perpetual snow. We know that no clouds float over the lunar landscape, and that the atmosphere at the summits of the mountains, which correspond to the lunar limb, is certainly rarer than the air over the earth's surface at a height of 32 miles above the sea-level (*see* KNOWLEDGE, October 1889, p. 246). No clouds float at such a level above the earth. But we have plenty of evidence that water vapour exists in the earth's atmosphere quite independently of clouds, which only form in dust-laden air under certain conditions of temperature and saturation.

If there were no evaporation on the moon, and water-vapour was not continually being carried in the thin air and deposited on the mountain summits, we should expect to find the lunar snows accumulated in the valleys and plains, having descended, as mountain snows do, on the earth in the form of glaciers; no doubt more slowly than on the earth, for gravity at the moon's surface is only about one-sixth of gravity at the earth's surface. But the flowing down of a great body of snow in the form of ice would take place as surely on the moon as it does here, though it would require six times the depth of snow upon the moon to consolidate it into ice as is required here to consolidate snow at a similar temperature.

One of the reasons which causes so large a quantity of snow to be deposited on the tops of terrestrial mountains is that the mountain-sides, as the wind blows over them, cause upward currents in the air; the air in ascending expands, and as it expands it is chilled by its expansion and deposits some of the water vapour which it was able to hold in suspension at a warmer temperature. No doubt the same upward drift of aqueous vapour is continuously taking place in the moon's rarer atmosphere.* Following terrestrial analogies we should expect that the air over the lunar surface would become unequally warmed, and winds would be set up as on the earth's surface. The mountains will give rise to upward currents; expansion, and consequent chillings, must take place and the excess of water vapour will be deposited more freely upon the mountains than over the plains. Possibly upon the moon there is no general deposit over the plains, but only in the regions immediately around where the air rises and is chilled by its expansion.

During the long lunar day, the air must become loaded with water vapour to an extent that will increase the weight of the lunar atmosphere. This will cause the air to be compressed in faults and any other cavities of the soil which it can enter. During the lunar night, as the water vapour is deposited by the cold, the pressure will be relieved; and we should expect the imprisoned air to return to the surface and be chilled on its expansion, so causing a white deposit, even at low levels, around the place from which it issues.

The lunar glaciers must scrape out the valleys and carry down blocks as our terrestrial glaciers do. This will cause their lower ends to be formed of dirty ice; and if in the regions which they reach in their downward flow the evaporation in the course of the lunar month is greater than the deposit of fresh snow, the blocks and dirt contained in the ice will be ultimately left upon its surface. Such evaporation of the ice may take place below the freezing point.

The whole moon reflects light as if it were composed of a light-coloured rock, which Sir John Herschel, as is well known, compared to the weathered sandstone-rock of Table Mountain. A large portion of the moon's surface is mountainous and white, consequently the darker portions must absorb light like comparatively dark rock; and if the lower regions of the moon are covered with ice, its surface must be very dirty and discoloured with *débris* of a dark character. It seems more probable that in the lower regions we actually see the lunar rocks.

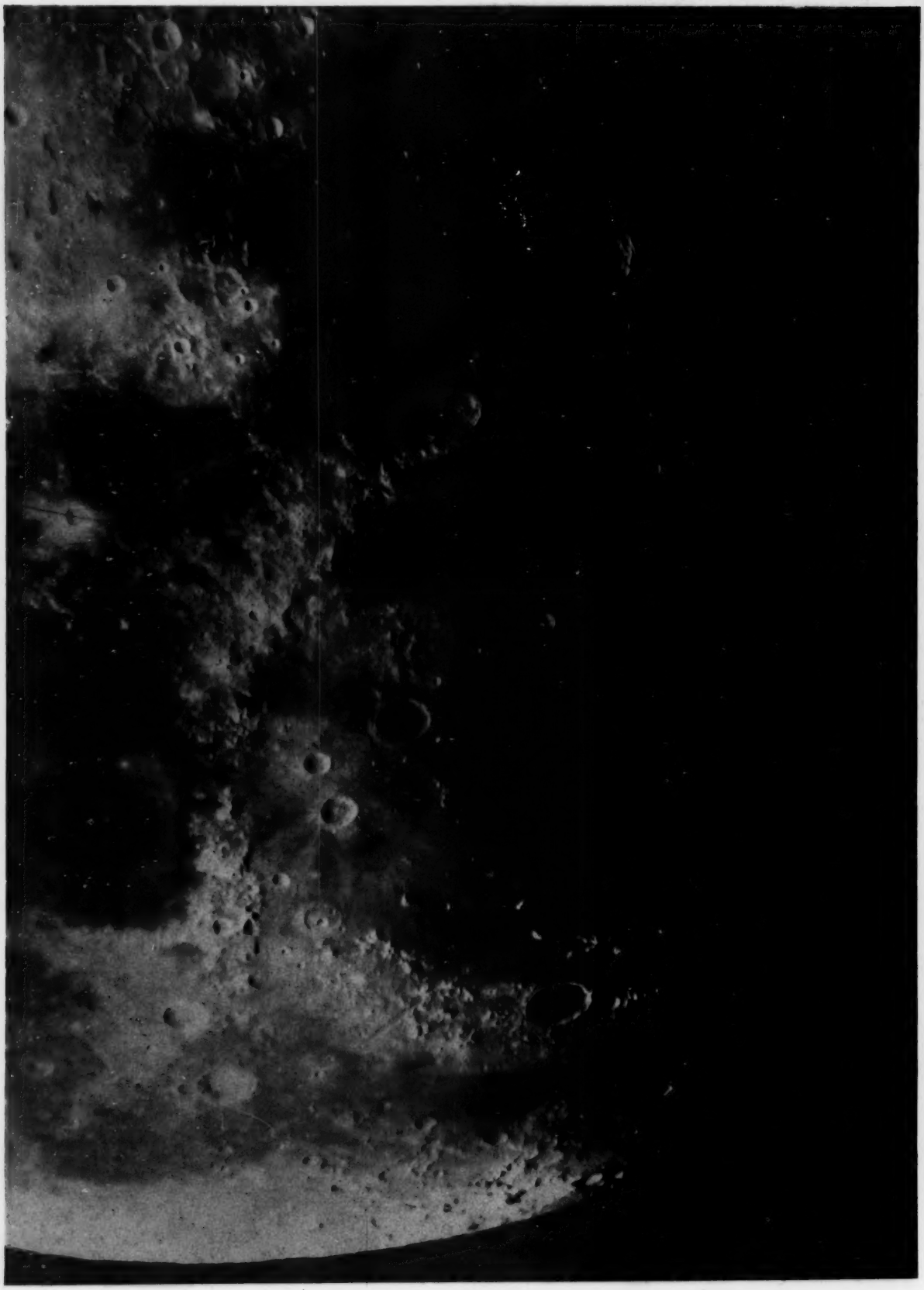
According to Messrs. Langley and Very the maximum temperature of the sunlit soil in the neighbourhood of the

* This narrow band is well shown in the photographs of the moon published in KNOWLEDGE, October 1889, as well as in the lunar photograph published in the May number 1890. In an ordinarily dense photograph of the full moon a narrow white line or band along the lunar limb is always over exposed. The greater brightness of the limb is strikingly visible to the eye when the old moon is seen in the young moon's arms; the whiter region along the limb then appears as a narrow line of light surrounding the ashy body of the moon (*See* KNOWLEDGE, Sept. 8, 1882). That this is not an optical effect due to contrast may be proved by holding a diaphragm so as just to cut out the surrounding sky.

* The existence of high cliffs and many lofty pinnacles upon the moon may, I think, be taken as pretty conclusive evidence that the moon has some atmosphere; for if there were only as much atmosphere at the summit of the lunar mountains as exists at the height of 100 miles above the earth's surface, the weathering action caused by the bombardment of meteors would be very considerable, for the force of a blow struck by a projectile varies as the square of its velocity, and even small particles moving with a velocity of 20 to 40 miles a second would soon break up and bring down the parts of a lofty cliff or pinnacle. The majority of the meteors we see become visible at a height of less than 100 miles, and are extinguished before they reach a height of 50 miles above the sea-level. We may feel very sure that the moon encounters about as many meteors, area for area, as the earth does; and we are probably safe in assuming that the density of the moon's atmosphere at the summit of the mountains, which when seen in projection form the lunar limb, is greater than the density of the earth's atmosphere at a height of 100 miles above the sea-level, and less than the density of the earth's atmosphere at a height of 32 miles above the sea-level.

XUM

SOUTH.



WEST. EAST.

WES

1. PHOTOGRAPH OF THE MOON 240 HOURS OLD.

Taken by MM. PAUL and PROSPER HENRY with their 13-inch refractor at the Paris Observatory, 28th May 1890.
Enlarged 15 diameters from the image in the principal focus.

Direct Photo Eng. Co., Limited, 9, Barnsbury Park, N.

XUM

SOUTH.

WEST.

EAST.

2. PHOTOGRAPH OF THE MOON 265 HOURS OLD.

Taken by MM. PAUL and PROSPER HENRY with their 13-inch refractor at the Paris Observatory, 23th May 1890.
The sensitive plate was placed behind an eye-piece which enlarged the image in the principal focus 15 diameters.

Direct Photo Eng. Co., Limited, 9, Barnsbury Park N.

XUM

lunar equator is a little above the freezing point. If the sun's action during the long lunar day melts the surface of the ice, the moisture will find its way downwards, forming rills which will unite into streams and flow down on the surface of the glaciers till they come to a crevassed region, where they will descend to the bottom of the glacier, forming, as on the Mer de Glace, moulins or ice-wells. The streams, the water of which has been warmed by the sun's rays, will then tunnel under the ice as they do under our own glaciers, and appear at a lower level charged with the finer detritus abraided from the rocks, which will ultimately be carried to the plains, or as far as the water reaches; but it is evident that there can be no lakes of any appreciable extent upon the moon, or we should occasionally see the sun's rays reflected specularly from such water surfaces. Such streams may be absorbed into the lunar soil, or they may be spread out into deltas of rough ice. The surface of our terrestrial glaciers does not reflect specularly; it resembles snow rather than ice. This is caused by the breaking up of the surface by the solar heat, as Prof. Tyndall remarks in his charming book on *The Forms of Water*: "When you pound transparent rock-salt into powder it is as white as table-salt, and it is the minute fissuring of the surface of a glacier by the sun's rays that causes it to appear white."

Our illustrations have been made from two beautiful photographs of the Mare Imbrium and surrounding regions, which have been kindly given me by Messrs. Paul and Prosper Henry for reproduction in KNOWLEDGE. They show that the streaks from Copernicus are evidently a little raised above the general level of the Mare Imbrium, as if they were lava streams. They certainly differ in their branching character from the great straight streaks which radiate from Tycho. The curious great straight cleft or valley which passes through the Lunar Alps is also well shown, especially on Plate I. On Plate II. it is a less striking feature, as the sun has risen higher. According to Webb it is about 83 miles long and from $3\frac{1}{2}$ to $5\frac{3}{4}$ miles broad, and is over 11,000 feet deep. It has a wide trumpet-shaped mouth where it opens into the northern—that is, lower—side, on the photograph, of the Mare Imbrium.

Notices of Books.

New Zealand for the Emigrant, Invalid, and Tourist. By JOHN MURRAY MOORE, M.D. (Sampson Low & Co.) This is a capital handbook for the three classes of persons referred to in its title. The author, a medical man of some eminence, after travelling in many parts of the world, became a nine-years' resident in New Zealand, and is thus practically fitted to form an estimate of the colony in comparison with other places; and to it he assigns the palm. He gives useful advice to intending emigrants, directs invalids as to localities suited for their complaints, and informs tourists of the parts best worth seeing. In a book of about 250 pages, we have a considerable amount of information as to the physical features, climate, productions, inhabitants (native and European), government, commerce, social life, education, and prospects of the colony, together with descriptions of the principal towns, public works, &c. The author divides the islands into four climatic zones, showing the suitability of each to certain classes of disease; and gives an interesting description of the hot mineral springs and geysers, and their medicinal properties, and of the famous pink and white Terraces of Rotomahana, to which is added a graphic account of their destruction by the great volcanic eruption of 1886. Interesting details are also given of the present aspect of the "Wonderland Region," with its great fissure nine miles long and from a furlong to a mile and a half broad, the depth extending in some parts to 900 feet. The tourist in search of the picturesque is strongly urged to visit the West Coast Sounds and fjords, the grandest of which, Milford Sound, with its perpendicular sides towering up from 3,000 to 4,000 feet, and its waterfall of 540 feet, "surpasses in wondrous beauty Monte Rosa, the Matterhorn, or Mont Blanc." A variety of information is also given as to the flora and fauna of the country, both native and acclimatized, and its vast mineral treasures. A copious index and a number of a clear and useful maps, most of them on a large scale, add further to the value of this well-printed and carefully written guide-book.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of KNOWLEDGE.

SIR,—In the September number of KNOWLEDGE, p. 213, there is an interesting letter from R. Chartres, which contains, however, one statement that needs a slight modification. It is there stated that any fraction of the form $\frac{1}{nr-1}$ (where r is the radix of notation), when expressed as a recurring decimal, is of the form $abc\ldots ka_1b_1c_1\ldots k_1$, in which $a+a_1=b+b_1$ &c.$=r-1$. Now, although in the decimal notation this proposition is generally true, it does not hold, *as regards the last equation*, of such fractions as $\frac{1}{39}$ and $\frac{1}{69}$, which are severally $\cdot\dot{0}25641\dot{0}$ and $\cdot 014492753623188405797\dot{1}$; for although $0+6=2+4=5+1$, we cannot add $=10-1$, whilst in the other example $0+3$ is not equal to $1+1$, and the sum of the two halves of the period amounts to eleven threes, not eleven nines.

9, Oakroyd Terrace, Bradford. J. WILLIS.
28 Oct, 1890.

THE WORD "BROAD."

To the Editor of KNOWLEDGE.

DEAR SIR,—The great dictionary edited by Dr. Murray is, as is well understood, on an historical basis, hence the cautious manner of its etymologies. No doubt Mr. Pincott's suggestions are very plausible, but the question arises, are they supported by instances? Take Mr. Pincott's suggestion that *Brad* is a related word. He says it is "a thin flattish nail." Where does he get the notion of *flattish* put in? Skeat, referring to an old English author, finds it explained as "a hedlesse nail," and refers to its kindred word *brord*, a spike, or blade, or spire of grass, still in Scotland pronounced *braird*, and applied to the first appearance of wheat or oats above ground. "It is a variant," says Skeat, "of the Anglo-Saxon *byrst*, a bristle," and he goes on to show that bristle is a diminutive of *brad*. In Scotland, *blad*, which your correspondent says is an old word for a firm *flat* blow, is a word still in use, but mostly impersonal, as "it 's bladdin on o' weet," *i.e.* the rain is driving on. "To blad" is also used with us meaning "to slap," but this use is all but obsolete.

Dumfriesshire. JAMES SHAW.

To the Editor of KNOWLEDGE.

DEAR SIR,—Thank you for giving me an opportunity of replying to Mr. Shaw. He implies that my suggested relationships of the word *Broad* are unhistorical, and asks if they are supported by instances. What possible instances are required to prove that the words I have cited are applied

to objects of which extended surface is a characteristic? The puzzle would be to find such a word as *board* applied to any object which was globular, knobby, or contorted; every instance of its use will show that it conveys the idea of *broad* surface. The "historical basis" has nothing to do with the question, unless it can be shown that the words have changed their meaning by efflux of time. Mr. Shaw also asks why I ascribe a sense of flatness to a brad. I stated quite plainly in my paper "which the Dictionary itself defines as 'a thin *flat*tish nail.'" And I may add that the Dictionary prints *flat* in italic, to indicate that that is of the very essence of the thing. I have used many sorts of brads in the course of my life, and know as a fact that they are flattish nails, with generally a small projection by way of head. In the case of $\frac{1}{2}$-in. brads the projection is scarcely noticeable; but in $\frac{3}{4}$-in. and 1-in. brads it is plain enough. Mr. Skeat's definition is wanting in practical knowledge. The Scotch words which Mr. Shaw adduces afford further instances of the same sound being applied to such ribbon-like objects as grass.—Frederic Pincott.

English Trout in America.

To the Editor of Knowledge.

Sir,—That a change of residence has frequently a beneficial effect upon trout is evidenced by the results attending their transference from one locality to another, but more especially is this the case when introduced into the waters of certain foreign countries. For instance, several varieties of American trout, that have been reared by me at this establishment, grow faster than they do in their native waters, and, conversely, English trout introduced to transatlantic waters achieve larger proportions than do their American congeners. Again, their sporting qualities improve by the change, for while we applaud the *Salmo fontinalis* here, the angler on the other side of the Atlantic states that ours is the gamest trout handled with a rod, and is considered superior to his own fish in its growing capacity. Then there is another point affecting colouration. Handsome as is the colouring of American trout, our own trout when transferred to American waters are considered by American authorities to be more brilliantly coloured than their own fish reared in the United States.

After a lengthened experience in raising all kinds of trout, both natives of this country and abroad, I can well understand that they, in certain instances, undergo a change for the better on being transferred to new homes; but nevertheless I hold to the opinion that our present experience of American and other foreign strangers does not justify their being planted in any but enclosed waters.

Yours truly,

Midland Counties Fish Culture Establishment, Malvern Wells. John Burgess.

WHIN BLOSSOM, AND OTHER EXPLOSIVE FLOWERS.

By the Rev. Alex. S. Wilson, M.A., B.Sc.

A CONSPICUOUS feature of the landscape in many parts of the country during the spring months is the great mass of yellow blossom with which the whin or furze bushes are covered. These common flowers, apart from their beauty, have a special botanical interest. They belong to the class of explosive flowers. It may surprise some to learn that such a character belongs to more than one of our native wild flowers. The reader can however rest assured that though the term correctly describes their character, no danger to human life or property need be apprehended. The explosion, though well defined, is very harmless, and can be witnessed by anyone who will take the trouble to touch the tips of a number of the unopened flowers of the whin. If the flowers be sufficiently advanced, and the state of the atmosphere at all favourable, some of them when touched will be seen to burst open suddenly and discharge a little puff of yellow powder. This miniature explosion is even better seen in the flowers of the broom, where, however, a double explosion occurs, two puffs of yellow dust being ejected.

The explanation of this curious phenomenon is to be found in the need which flowers have for the visits of insects. Bees especially are of use as carriers of the pollen, or flower-dust, which they unconsciously transfer from flower to flower. In this way insects are instrumental in bringing about cross-fertilisation. A large number of plants are so dependent on the visits of insects that if they are excluded the flowers yield no seeds. In general, both the quantity and quality of the seeds are improved by cross-fertilisation. All brightly-coloured flowers are adapted for cross-fertilisation by insect agency. The gay-coloured petals, the perfume, and the honey, are so many attractions to allure insects to the blossoms.

In addition to these attractions, we find in many flowers arrangements which prevent the visitor departing without first being well dusted with pollen to carry to other flowers. A remarkable insect-dusting apparatus is seen in the flowers of various species of sage. In them the bee is made to press against a lever which brings down the pollen-sac on the insect, leaving a yellow splash on the exact part of its back which in the next flower visited will come in contact with the stigma, or surface prepared for the reception of the pollen. The insect-dusting mechanism is of the most varied kind, and often extremely curious and ingenious. In the bird's-foot trefoil it might be compared to a force-pump, and in some of the composite flowers it acts like a syringe.

The explosion and ejection of the little pollen-cloud from the flowers of the whin is another contrivance serving the same purpose. When a bee touches the blossom the pollen is scattered all over its body, so that when it visits another flower it can hardly avoid leaving some of its burden and thus performing an essential service to the plant.

The pollen of flowers is in general more or less adhesive, so that it readily clings to the hairy covering of an insect. Thus the pollen of the rhododendron reminds one of cobweb. In a few cases the pollen is not sufficiently adhesive in itself; the milkwort and periwinkle may literally be said to tar and feather their guests, since the insect's proboscis, inserted to obtain the honey, is first smeared with viscid matter, to which the pollen adheres as the insect withdraws from the flower.

The sudden discharge of little clouds of pollen is also observed in some flowers, such as the nettle, pellitory, and several grasses which do not require the services of insects. The common nettle occurs in two forms; the male plant which produces the pollen is quite distinct from that which bears the seeds. The pollen is blown from the one to the other by the wind. On a warm summer day it is interesting to watch the little flowers of the nettle discharging one by one their lilliputian artillery, the successive puffs emitted suggesting to the mind the volumes of smoke one has seen issuing from the port-holes of a distant man-o'-war.

The forcible discharge of the pollen in the case of wind-fertilised flowers may be of use in two ways; the pollen is thrown clear of the flower that produced it, so

that self-fertilisation is prevented, and is at the same time scattered on the wind, and has a better chance of being carried away in the direction of the flowers where it is required.

The bright golden petals of the whin and broom are, however, sufficient proof of these flowers being insect-fertilised, for a wind-fertilised flower can derive no advantage from brilliant colours. Accordingly, in the wind-fertilised class dull and obscure tints prevail, and, as we might expect, no secretion of honey occurs. The flowers of this division are devoid of smell, so that they present little or few attractions to insects. Although the whin and broom have no honey to offer their guests, like many honeyless flowers they produce an excess of pollen, which constitutes a strong attraction to pollen-feeding flies and bees. All species of insects are not equally well adapted for the work of cross-fertilisation, and the attraction, whether it consist of nectar or pollen, must, if possible, be reserved for the proper kind of insect. In the honeysuckle, for example, the sweet fluid is secreted deep down at the base of the long, narrow flower-tube, where it can only be reached by the slender proboscis of a butterfly or moth. For a similar reason, the pollen of the whin and broom flowers is at first concealed within a closed pouch, formed by the union of the two lower petals. Within this carina or pouch the style and stamens lie curved like a spring. They press against the upper wall of the pouch, and the tension is so great that when the tip of the flower is touched the upper side of the pouch ruptures, setting free the stamens, which spring up, throwing a shower of pollen over the insect. Only the larger kinds of bee, it would appear, are able to exert sufficient force to cause the explosion. The pollen is therefore, in the first instance, reserved for them; but when the flower has once been exploded it remains open, and the smaller bees, flies, and beetles come to glean what is left, and act as supplementary fertilisers.

Relatively to the size of the creature, the shock sustained by a bee on causing one of the flowers of the whin or broom to explode must be considerable. The bee appears, however, to have grown accustomed to the experience; the shock, at any rate, is not sufficient to drive it away; at most, the insect pauses for a moment, and then resumes work with increased diligence. Several species of *Medicago* and *Genista*, and, according to Hildebrand, some of the *Marantea* produce flowers which resemble those of *Ulex* and *Sarothamnus* as regards their explosive character.

THE BED-BUG.—IV.

By E. A. BUTLER.

BUGS are extremely prolific, and according to Southall, who kept many for observation, sometimes produce eggs as frequently as four times during the course of the summer, whence their remarkably rapid multiplication can be readily understood. The small size of the eggs, and the lurking, nocturnal, and obscure habits of the insects themselves, caused their true origin, like that of many another insect pest, to remain for a long time unknown, and, indeed, unsought. Their constant association with uncleanly conditions led to their presence being accounted for by a recourse to that common refuge of ignorance, the doctrine of spontaneous generation, and by this convenient hypothesis the occurrence of all small creatures whose real origin was unknown was explained away, even down to comparatively recent times. So acute and painstaking an observer as Harvey, the discoverer of the circulation of the blood, falls into the commonly-received error, and speaks of "grubs and earth-worms, and those that are engendered of putrefaction, and do not preserve their species." In Aristotle's time it was believed that bugs originated from the sweat of animals; and even when we come down to a period 2,000 years later, so full of vitality is error, Mouffet, from whose treatise we have already quoted, states, without any hesitation, and, in fact, with strong asseveration, that they arise from juices which exude from wood, and from putrefying moisture around beds (!); the latter, let us hope, a gross libel on the sanitary arrangements of his time. He mentions also a current popular belief that new bugs arise, hydra-like, from the crushed remains of other bugs—a belief which, one would have thought, would have operated largely in favour of the persecuted; for who would crush one if thereby two were created?

Bugs are extremely tenacious of life, and, being so thin of body, a multitude of them can pack themselves away in the narrowest cracks and crevices, placing their legs in the same plane as the body; hence the difficulty

FIG. 15.—THE FLY BUG (*Reduvius personatus*), a Devourer of Bed-Bugs.

of eradicating them if they once obtain a firm lodgment in a house. The ordinary insect-powders are of very little avail when they retreat to their narrower hiding-places, between floor-boards, behind wainscoting or loose wall-papers, or in the chinks of the joints of bedsteads; and something which will be more penetrating needs to be employed. Hence one or the other of two methods has chiefly to be relied upon—either the application of a mobile and penetrating liquid, or the production of a noxious vapour. Liquids of the benzine and petroleum type are the best to use under the former head. Dr. Packard recommends an exceedingly simple preparation,

consisting of "30 parts of unpurified cheap petroleum mixed with 1,000 parts of water." Frank Buckland recommended benzine, which he squirted into their hiding-places by means of a small glass syringe, with the effect that they turned out at once, and could be despatched by further applications of the same fluid. The same naturalist describes, with his customary quaintness, a raid he made on kitchen cockroaches with similar artillery:—"I took with me an assistant, three glass squirts, and a wide-mouthed bottle of benzol. As the blackbeetles scuttled away to their holes, I kept firing at them, killing some dead, and wounding others, for next morning we found plenty of 'dead birds' about the kitchen. With an active loader to manage the second syringe, and plenty of black game, blackbeetle-shooting at night in the kitchen will give as much sport as rabbit-shooting in a warren by day." Methylated spirit, and diluted carbolic acid are other liquids that may be employed with more or less success, whilst boiling water is certain death to any that it may reach, in whatever stage of life they may be.

For the vapour method, sulphuric dioxide appears to be the best insecticide capable of application on the large scale. This gas, which is the cause of the suffocating odour when sulphur is burnt, is easily produced in sufficient quantity by burning a little brimstone in a metal dish. Of course the room to be operated upon must be kept closed as completely as possible during the process, to prevent the escape of the fumes. A *thorough* fumigation by this method may be expected to destroy all that happen to be beyond the egg state; but unless the gas is in a very concentrated condition, the bugs will withstand its action; also further fumigations may become necessary to reach those that were in the egg condition at the time and do not hatch till afterwards.

In the days of wooden bedsteads, the extermination of these pests was a much more difficult matter than it is to-day. A good four-poster, with all its paraphernalia of trappings, was a perfect paradise for them, and afforded endless retreats in which they could secrete themselves by day, creeping out at night to assail their unconscious victims. Their eradication then became so formidable a business that it was necessary to call in the aid of experts. John Southall himself made bug-hunting his specialty, and evidently regarded himself as a great benefactor to humanity in consequence of the prowess he achieved in this direction. Of course he had a specific of his own, the composition of which he kept a profound secret, relating that he had obtained the knowledge of it from an old grey-haired negro whom he met in Jamaica. On the title-page of his "Book of Bugges" he describes himself, with the customary circumlocution of the period, as the "Maker of the Nonpareil Liquor for destroying Buggs and Nits, living at the Green Posts in the Green Walk near Faulcon Stairs, Southwark." He seems to have found abundant employment for a considerable staff of *employés*, who worked under his personal supervision; and his clients were to be found even amongst the most well-to-do classes. His charges were half-a-guinea for ridding the most elaborate bedsteads, and proportionately smaller amounts for those of an inferior style, an ordinary four-poster with plain furniture being undertaken for six shillings.

This was the state of affairs in London about a century and a half ago, and so common was the infliction that it can scarcely have been considered much of a disgrace to be in need of Southall's services. The substitution of plain iron bedsteads for the heavily-draped wooden structures used by our ancestors, and the increase of habits of cleanliness in households, have greatly diminished the liability of respectable families to the attacks of these hideous pests, and have therefore been the means of more completely confining them to the poorer districts and slums, where, needless to say, they are still as numerous as ever. Southall charges the builders of his day with introducing bugs into newly-built houses, by using second-hand doors, chimney-pieces, &c., obtained from infected dwellings, the eggs of the insects being thus unintentionaliy brought in; in particular he states that houses in Hanover and Grosvenor Squares were thus supplied before they were inhabited. He undertakes to inspect houses for intending tenants, guaranteeing to determine whether they are infested or not.

Bugs have some natural enemies which might aid in their extermination where they not themselves too repulsive and annoying to be endured. The cockroach, as already mentioned, devours them, and spiders are said to do the same. There is also an insect called the Fly-Bug, which is occasionally found in houses, and preys upon them to a large extent. It belongs to the order Hemiptera, and indeed is not very remotely related to the bed-bug itself. It is called *Reduvius personatus*, and is a large dark-brown insect, about two-thirds of an inch long (Fig. 15). Both pairs of wings are fully developed, and it is a good flier, being active chiefly at night; it is readily attracted by a light, and hence often flies in at the open windows of rooms in which a light is burning. In its larval and nymph condition it has the remarkable habit of enveloping itself in a coating of dust and bits of rubbish, the whole surface, including legs and antennæ, being thus covered. The antennæ, which are slender, become by this process apparently as stout as the legs, and hence the insect has the appearance of an eight-legged creature, and might be mistaken for a spider, but for the deliberateness of its movements. The refuse matter simply rests on the skin, and may be removed by brushing with a camel's hair brush. This insect is one of the largest of our British Hemiptera, and is a rapacious creature, entirely carnivorous in its tastes. It destroys various kinds of insects, and the bed-bug amongst the number. Of course, the insects are not devoured; they are pierced by the short proboscis or rostrum, which is constructed similarly to that of the bed-bug itself, and only their juices sucked out.

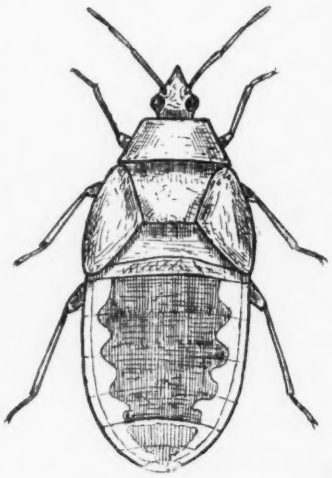


Fig. 16.—Nymph of *Lyctocoris campestris* (sometimes mistaken for Bed-Bug).

Several plants were formerly used as cimicifuges, their smoke, when burnt, being believed to be obnoxious to the insects. Cow-dung and horsehair were used in a similar way. Superstition and credulity went so far as to place confidence in the occult influences of such objects as stags' horns, rabbits' feet, foxes' ears, &c., when hung up near beds.

So disgusting an insect as *Acanthia lectularia* could not

fail to have medicinal virtues attributed to it at a time when the pharmacopœia contained multitudes of nameless horrors. Pliny states that it was in his time regarded as an antidote to the bite of serpents, "especially of asps," adding that fowls which had eaten bugs would not be injured if bitten on the same day by an asp. Another Roman author says that an infusion of the bodies of seven crushed specimens was administered to patients who were sinking into an insensible condition, with the intention of rousing them from their lethargy!

The bed-bug is not the only species of its genus that is found in this country, though by far the commonest. Three others have been described, none of which, however, are to be regarded as directly parasitic on man, though some of them, and probably all, do not object to a meal of human blood when they can get the chance. One is found in pigeon-cots, where it attacks the birds, another in martins' nests, and the third in bats' nests. They are all very much alike, and closely resemble our domestic pest. The first two may sometimes be found climbing the walls of houses, or on window-sills, in the neighbourhood of dove-cots, and under martins' and swallows' nests.

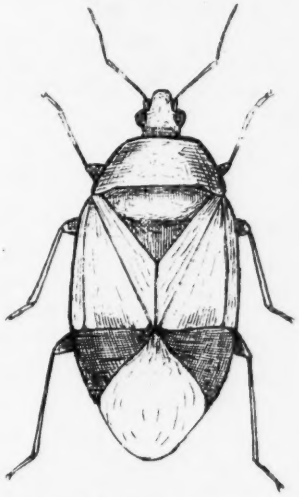


FIG. 17.—*Lyctocoris campestris*, in its perfect winged form.

Besides these, another insect (Fig. 16) is, in its larval condition, sometimes confounded with the bed-bug. It is commonly found in barns amongst the miscellaneous rubbish that accumulates on the floor, as well as under and around haystacks, &c. It is called *Lyctocoris campestris*, and is an outdoor insect, and may be found in hedges amongst dead leaves and other *débris*. In its perfect condition (Fig. 17) it could not be mistaken for our domestic pest, as it is fully equipped for flight, both pairs of wings being completely developed. But in its immature stages it certainly does present a superficial resemblance to the corresponding forms of its not very remotely connected ally. Reddish brown in colour, it is, however, smoother and more elongate than the bed-bug, as well as considerably smaller. It is not parasitic, and is therefore harmless.

MAGIC SQUARES.

By A. C. RANYARD.

JUDGING from the letters I receive, there are a great many readers of KNOWLEDGE who take an interest in magic squares. I have hitherto not published any letters on the subject, because they have either been too long and complicated or the writers have supposed themselves to have made discoveries with regard to some obvious property or method of construction. Perhaps the general readers of KNOWLEDGE, as well as some of my correspondents, may be interested by my putting together some of the well-known facts with regard to such squares.

A magic square consists of a square number of numbers, not necessarily consecutive numbers or integers, arranged in a square so that the sums of the numbers in each vertical column and horizontal row are equal. The numbers may also be so arranged that the sums of the numbers on each of the two diagonals of the square are equal to the sum of the numbers in any row or column.* The power of constructing such squares is, as far as I am aware, of no practical use, but the problem belongs to a class which stimulates thought and suggests arithmetical and mathematical investigations. If the square number of numbers to be arranged in a magic square be the consecutive integers from 1 up to n^2, the sum of each column or row must be $\frac{n\,(n^2+1)}{2}$ for the sum of all the numbers from 1 to n^2 is $\frac{n^2\,(n^2+1)}{2}$ and there are n columns each of which must give the same total.

When any numbers have been arranged in a magic square, an infinite number of other magic squares may be derived from it, by multiplying or dividing all the numbers or elements of the rows and columns by the same number, or by adding or subtracting the same number in every case. Thus, if we have the numbers 1 to 9 arranged in a magic square we may at once arrange any other nine numbers in arithmetical progression in a magic square; for example, given the square—

8	1	6
3	5	7
4	9	2

It is required to arrange the numbers 1, 4, 7, 10, 13, 16, 19, 22, 25, in a magic square. Multiply each of the numbers of the given square by 3 and we have the magic square

24	3	18
9	15	21
12	27	6

Subtract 2 from each of these numbers and we have the magic square

22	1	16
7	13	19
10	25	4

in which each row and column adds up to 39 instead of 15, as in the original square. It will be found, on trial, that the numbers 1, 2, 3, 4, cannot be built up into a magic square, and that only one magic square of 3 exists; that is, all the magic squares that can be built with the first nine numbers can be obtained from the one form by shifting the rows or columns. A magic square of the first 16 numbers can be built in many ways; *at least*, 48 different magic squares of 4 exist.

According to Mr. A. H. Frost, of Newnham, Cambridge, who is a great authority on magic squares and cubes, the art of making magic squares, or, rather, some magic squares, has been practised in India for more than two thousand years. In his first article in the *Quarterly Journal of Mathematics*, 1865, he mentions a

* Mr. A. Frost, long resident at Nasik, in India, as a Missionary of the Church Missionary Society, invented a very elegant method of constructing magic squares, in which the same total as that obtained by adding together the numbers in any row or column is obtained by the same number of summations in a direction parallel to the diagonals, the square being moved in the direction of the sides till the opposite sides are in contact, in order to supply the number of figures in the direction parallel to the diagonal equal to the number of figures in the side. Or a similar magic square may be supposed to be placed beside the original one, and the line along which the additions are made will then pass from the one square into the other. Such squares, which have other interesting peculiarities, have been christened *Nasik* squares.

magic square with diagonal summations engraved in Sanscrit on the gate of a fort at Gwalior before the Christian era. Jacques Ozanam (1640–1717) in his *Récreations mathématiques et physiques*, published in Paris in 1694, says that the Brahmins of Surat had a set rule for making squares on *odd* edges. He gives the first three odd squares made by their method, and the rule for remembering it.

8	1	6
3	5	7
4	9	2

30	39	48	1	10	19	28
38	47	7	9	18	27	29
46	6	8	17	26	35	37
5	14	16	25	34	36	45
13	15	24	33	42	44	4
21	23	32	41	43	3	12
22	31	40	49	2	11	20

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

If the squares are examined and the path of the figures 1, 2, 3, 4, 5, 6 . . . noted it will be seen that the numbers mount upward diagonally; when the top row is reached the numbers pass on to the bottom row as if it came immediately above the top row. When the last, or right-hand column, is reached, the series of numbers passes into the first or left-hand column, as if it immediately succeeded the right-hand column; and when a square which has been filled up is reached, the path of the series drops a row vertically and begins to mount again. Cornelius Agrippa (1486–1535) gave seven magic squares on edges of 3, 4, 5, 6, 7, 8, 9, which were assigned or consecrated to Saturn, Jupiter, Mars, the Sun, Venus, Mercury, and the Moon. A Greek named Moscopulus is said to have written a MS. on magic squares, which is now in the National Library of Paris. His method seems to be similar to what is known as Bachet's method, which may be found in his *Problèmes plaisans et délectables qui se font par les nombres* (2nd edition, 1724).* It is in fact similar to the Indian method, except that the numbers begin in the square immediately below the middle square, and proceed downwards towards the right hand instead of upwards. Thus—

4	9	2
3	5	7
8	1	6

22	47	16	41	10	35	4
5	23	48	17	42	11	29
30	6	24	49	18	36	12
13	31	7	25	43	19	37
38	14	32	1	26	44	20
21	39	8	33	2	27	45
46	15	40	9	34	3	28

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

C. Agrippa seems to have been acquainted with some even as well as odd squares, and Bachet gives specimens of even as well as odd squares, but no proper method of making them.

M. Poignard, a Canon of Brussels, published in 1703 a treatise on magic squares, which contained a method of making certain even squares which has slowly been brought to perfection, first by M. De la Hire, who generalised the method for squares with a "double of odd" and "double of even" edge, and then by Mr. A. H. Frost.

The following method avoids the transpositions which M. De la Hire makes inseparable from his method of making squares on a double of odd edge, *e.g.* 6, 10, 14. Commence by arranging a square of consecutive figures, so that no figure occurs twice in the same line or column.

Magic Square of 3.

(1)

1	3	2
3	2	1
2	1	3

Suppose the figure taken up and turned through a right angle in the plane of the paper in the direction of the hands of a watch, thus—

2	3	1
1	2	3
3	1	2

(2)

Now apply figure (2) to figure (1), placing the numbers of figure (2) to the right of each of the numbers of (1), thus—

(3)

12	33	21
31	22	13
23	11	32

Now suppose the figures of (3) to be numbers in the scale of 3 with three permitted to appear; the numbers then become—

5	12	7
10	8	6
9	4	11

(4)

Now subtract 3 from each number of (4) and—

(5)

2	9	4
7	5	3
6	1	8

the magic square of 3 is produced.

Magic Square of 4.

1	2	4	3
4	3	1	2
3	4	2	1
2	1	3	4

Perform the same operation that made the square of 3, and we produce first—

12	23	44	31
41	34	13	22
33	42	21	14
24	11	32	43

and then, by supposing the numbers to be in the scale of 4, with 4 permitted to appear, we obtain a series of numbers such as will make a magic square of 4 when 4 has been subtracted from each. The result is the following

2	7	16	9
13	12	3	6
11	14	5	4
8	1	10	15

magic square of 4.

* Bachet says, p. 162, "I'ay veu en plusieurs autheurs disposez en ceste sorte tous les nombres despuis l'vnité iusques aux sept nombres quarrez consecutifs commençant à 9 a sçauoir 9, 16, 25, 36, 49, 64, 81. Mais la reigle pour les disposer ainsi, ie ne l'ay treuuee en aucun autheur. Or apres auoir beaucoup speculé là dessus, i'ay en fin treuué une reigle tres-belle et tres-facile pour tous les quarrez impairs: mais pour les pairs, ie n'ay peu rencontrer aucune jusques á present qui soit parfaicte et qui me contente." Bachet then gives his rule in a form which would hardly be recognised by those who have learnt it in the form in which it is now generally quoted.

MAGIC SQUARE OF 5.

1	4	2	5	3
4	2	5	3	1
2	5	3	1	4
5	3	1	4	2
3	1	4	2	5

Treated the same way as 3 and 4, we first produce—

13	45	22	54	31
41	23	55	32	14
24	51	33	15	42
52	34	11	43	25
35	12	44	21	53

and then the magic square of 5; thus—

3	20	7	24	11
16	8	25	12	4
9	21	13	5	17
22	14	1	18	10
15	2	19	6	23

MAGIC SQUARE OF 6.

6	2	4	3	5	1
6	5	3	4	2	1
1	5	4	3	2	6
1	2	4	3	5	6
1	5	3	4	2	6
6	2	3	4	5	1

Treated in the same way as the previous squares, produces first

66	21	41	31	56	16
62	55	32	45	25	12
13	53	44	34	23	64
14	24	43	33	54	63
15	52	35	42	22	65
61	26	36	46	51	11

and, finally, in the same way as the others, a magic square of 6 is produced; thus—

36	7	19	13	30	6
32	29	14	23	11	2
3	27	22	16	9	34
4	10	21	15	28	33
5	26	17	20	8	35
31	12	18	24	25	1

Mr. A. Frost's method of making Nasik magic squares and magic cubes is founded on the property referred to above, viz., that any number may be added or subtracted from each figure of a magic square or cube, and it will still retain its magic properties. Hence the constant sum of any row or column may be made zero.

Suppose a Nasik square to be formed of n^2 undetermined letters in the place of figures, the various summations will furnish us with 4 n equations, each containing the algebraical sum of n letters equated to zero. Particular solutions of these equations show that when n is even, the square is composed of four supplementary squares lying about the diagonals in pairs. The squares about any diagonal may be obtained, the one from the other, by sliding it along the diagonal into the new position, and changing the sign of each term. When the n is odd, the terms follow one another in the course of a knight's move at chess; and when further progress in its proper knight's path is hindered by the want of cells, the square is supposed to slide along in the direction of its rows, columns, or diagonals till the opposite sides or angles are in contact; the letter then passes into the square on the opposite side. But the method fails when the letters taking this knight's course come together in another cell, which may be shown to be the case when n is a multiple of 3.

A general method of making magic squares by bordering or surrounding known magic squares with figures suitably chosen was proposed by Mr. W. A. Firth, a late scholar of Emmanuel College, Cambridge,* in a pamphlet published in 1887. That magic squares might be bordered so as to still retain their magic qualities has been known since the time of Ozanam.

If it is proposed to turn a magic square of 3 into a magic square of 5—the numbers running consecutively upwards—we must commence by adding 8 to each of the numbers in the 3 square, for the average number of a 3 square is 5, while that of a 5 square is $\frac{1+25}{2}$ or 13. We thus obtain the square

10	15	14
17	13	9
12	11	16

This has to be surrounded with the numbers—

25 and 1
24 „ 2
23 „ 3
22 „ 4
21 „ 5
20 „ 6
19 „ 7
18 „ 8

which must be placed opposite to one another in pairs as I have written them, so as to maintain the same average and make the total of each column or row 65. A border can always be made, with the largest number in the corner. We have then to make a column and row, each equal to 65, with 25 for their common corner; and the only rule which need be attended to is that when we have used any number, say 5, its associated number 21 must not be made use of in building up the remainder of the column or row. Thus we have:—

3			3	21	22	18	1
24		and for the	24	14	9	16	2
6		complete	6	15	13	11	20
7		square	7	10	17	12	19
25, 5, 4, 8, 23			25	5	4	8	23

The magic square of 6 has $\frac{1+36}{2}$ or $18\frac{1}{2}$ for its average number, which is 10 more than the average number for the magic square of 4. Take a magic square of 4, and add 10 to each number thus:—

26	12	13	23
15	21	20	18
19	17	16	22
14	24	25	11

A column and row, each with a total of 111, have to be formed from the remaining integers ranging from 1 to 36, remembering the rule as to associated numbers mentioned above.

We may select for our row 36, 27, 29, 9, 4, 6, and for our bordering column 36, 2, 3, 7, 32, 31, and we obtain the following magic square of 6:—

31	10	8	28	33	1
32	26	12	13	23	5
7	15	21	20	18	30
3	19	17	16	22	34
2	14	24	25	11	35
36	27	29	9	4	6

And thus, by Mr. Firth's method, any magic square with an even or odd side may be built up.

* Mr. Firth has died since these notes were written. I had hoped to obtain some communication from him for the readers of KNOWLEDGE, and forwarded a proof of the above to him for his criticism, only to learn that he had recently died.

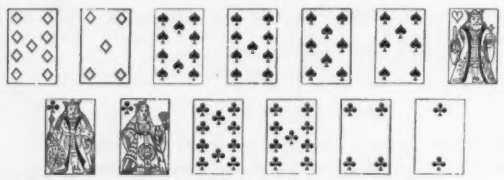
Whist Column.

By W. Montagu Gattie, B.A.Oxon.

EXCEPTIONAL PLAY.

THE following hand, which occurred recently in actual play at the Reform Club, is chiefly remarkable in that the dealer, holding six trumps to the knave, ace, only succeeded in making the ace. It also furnishes a curious instance of the advantage, under certain circumstances, of departing from stereotyped methods, although it must be remembered that such digressions call for the nicest judgment and should only be attempted by players of high proficiency. In this case, the skill of the original leader was assisted by some remissness on the part of both partner and opponent.

Hand No. 16.



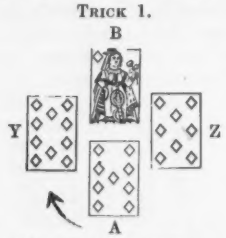
A's Hand.

Score—Love all.

Z turns up the ace of clubs.

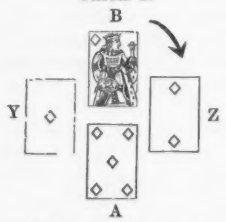
Note.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

Trick 1.



Tricks—AB, 1; YZ, 0.

Trick 2.

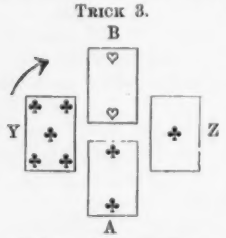


Tricks—AB, 1; YZ, 1.

Notes.—*Trick* 1.—A does not care to lead up to the ace of trumps; and, in preference to opening his own very moderate suit in spades, he leads the best of his two diamonds in order to see how the land lies.

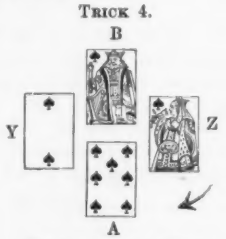
Trick 2.—Z has called for trumps, and probably holds five at least; at any rate, he must have four.

Trick 3.



Tricks—AB, 1; YZ, 2.

Trick 4.

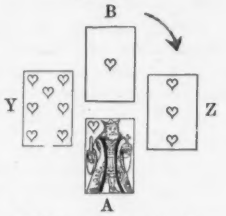


Tricks—AB, 2; YZ, 2.

Notes.—*Trick* 3.—Y has responded to his partner's call by leading the five of trumps. As Y cannot hold four trumps (see note to trick 2, coupled with the fact that A himself holds six), the five must be his best, and therefore the only other trump he can have is the three. Consequently Z has either four or five trumps remaining, headed by the knave.

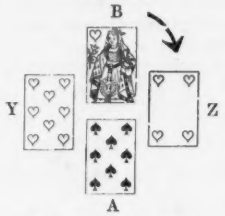
Trick 4.—Z is evidently making trial of a weak suit in preference to continuing the trumps, now that he finds one adversary is void of them. This trick shows that the ace of spades is with either Y or B.

Trick 5.



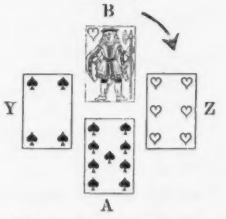
Tricks—AB, 3; YZ, 2.

Trick 6.



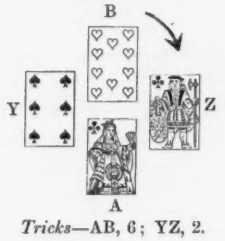
Tricks—AB, 4; YZ, 2

Trick 7.



Tricks—AB, 5; YZ, 2.

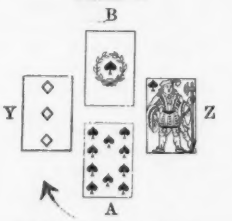
Trick 8.



Tricks—AB, 6; YZ, 2.

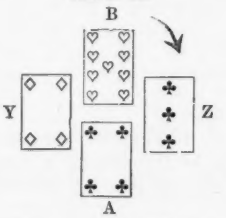
Note.—*Trick* 7.—Y has no more trumps; therefore Z holds knave, 8, 7, 6, 3.

Trick 9.



Tricks—AB, 7; YZ, 2.

Trick 10.



Tricks—AB, 8; YZ, 2.

Note.—*Trick* 9.—In order to make the three remaining tricks and game, it is necessary that B should hold the ace of spades, and that A should make the four of trumps. A can only do this if he is led up to through Z, and he therefore makes a bid for victory by playing his remaining spade.

Tricks 11 to 13.—A makes the winning trumps, and AB Score Five by Cards, and Win the Game.

A's Hand.	B's Hand.
C.—Kg, Qn, 10, 9, 4, 2.	
D.—9, 5.	D.—Kg, Qn.
S.—10, 9, 8, 7.	S.—Ace, Kg, 5, 3.
H.—Kg.	H.—Ace, Qn, Kn, 10, 9, 5, 2.
Y's Hand.	**Z's Hand.**
C.—5.	C.—Ace, Kn, 8, 7, 6, 3.
D.—Ace, Kn, 10, 7, 6, 4, 3.	D.—8, 2.
S.—6, 4, 2.	S.—Qn, Kn.
H.—8, 7.	H.—6, 4, 3.

Remarks.—*Trick* 1.—Many players would have led a spade, and many others the queen of trumps. A's hand, however, admits of considerable latitude of treatment. *Trick* 2.—B plays badly in returning the king of diamonds at once, although, as it happens, this helps to win the game. He should properly have opened the heart suit. *Trick* 3.—Z has, of course, nothing to gain by finessing. *Trick* 8.—Here Z plays badly. The other trumps being

marked in A's hand, the six was the right card; but the mistake is an excusable one under the circumstances. *Trick* 10.—Again Z trumps with the wrong card, and seals his fate. Of course he could have saved the game to a certainty by putting on one of the six, seven, eight, sequence. But many things may be forgiven to a player who takes up ace, knave, and four other trumps, and is only able to make one trick with them.

THE FACE OF THE SKY FOR DECEMBER.

By HERBERT SADLER, F.R.A.S.

THE number of sun-spots is slowly but steadily increasing. There will be a total eclipse of the sun on the morning of the 12th, invisible in the northern hemisphere, but visible as a partial eclipse in the southern half of Australia, New Zealand, &c. The line of central eclipse does not touch any inhabited land. Conveniently observable minima of Algol occur on the 13th at 11h. 30m. P.M.; on the 16th at 8h. 18m. P.M., and on the 19th at 5h. 7m. P.M. A maximum of the beautiful red variable star R. Leonis (*cf.* "Face of the Sky" for March 1889) occurs on the 9th.

Mercury is an evening star throughout the month, but owing to his great southern declination he is not very well situated for observation. During the first half of the month he is too near the sun to be well seen, but on the 19th he sets at 4h. 55m. P.M., or 1h. 5m. after the sun, with a southern declination of 24¾°, and an apparent diameter of 5½″. On the 31st he sets at 5h. 34m. P.M., or 1h. 36m. after sunset, with a southern declination of 21° and an apparent diameter of 7½″. He is at his greatest eastern elongation (19½°) on the 28th. During the last fortnight of the month he passes through Sagittarius into Capricornus, but without approaching any conspicuous star very closely. Venus comes into inferior conjunction with the sun on the 4th; after that she becomes a morning star, presenting a very thin crescent to the observer. On the 18th she rises at 6h. 2m. A.M., or just two hours before the sun, with a southern declination of 18¼°, and an apparent diameter of 56″. On the 31st she rises at 5h. 3m. A.M., or 3h. 6m. before the sun, with a southern declination of 16° 50′, and an apparent diameter of 45½″. She is stationary on the 24th, describing during the last fortnight of the month a tiny loop to the N.E. of β Scorpii, on the confines of Ophiuchus and Scorpio, but without approaching any naked-eye star.

Mars is, for the purposes of the observer, invisible, and Jupiter is too near the sun to be observed with any advantage. Saturn is becoming well situated for observation, rising as he does on the 1st at 11h. 51m. P.M., with an apparent equatorial diameter of 17¼″ (the major axis of the ring being 39¾″ and the minor 1¾″), and a northern declination of 7°. On the last day of the month he rises at 9h. 55m. P.M., with an apparent equatorial diameter of 18½″ (the major axis of the ring being 42″ and the minor 1½″), and a northern declination of 6° 59′. Titan will transit the planet's disc on the 5th and 21st, and be occulted on the 13th, but, unfortunately, none of these phenomena will be visible in England. On the evening of the 8th, Iapetus will be about 55″ south of the planet. Saturn is in quadrature with the sun on the 8th, and describes a very short path in Leo, being very near the 4th magnitude star σ Leonis. Uranus is, for the observer's purposes, invisible. Neptune is well placed for the amateur, rising on the 1st at 3h. 43m. P.M., with a northern declination of 19° 33′. On the last day of the month he rises at 1h. 40m. P.M., with a northern declination of 19° 26′. He thus describes a path between ϵ and ω Tauri, being nearly 50′ due south of the latter star at the end of the month.

December is a fairly favourable month for shooting stars, the chief shower being that of the Geminids, on Dec. 9–12, the radiant point being about 7h. 0m. R.A. +32° Declination, rising about 4h. 10m. P.M., and setting about 1h. 40m. A.M.

The moon enters her last quarter at 1h. 27m. P.M. on the 4th; is new at 3h. 11m. A.M. on the 12th; enters her last quarter at 8h. 36m. P.M. on the 18th, and is full at 5h. 57m. A.M. on the 26th. There will be a near approach of the 3½ magnitude star η Leonis at 4h. 30m. A.M., on the 3rd, at an angle of 143° from the lunar vertex. The 6th magnitude star B.A.C. 4,647 will disappear at 4h. 47m. A.M. on the 8th, at an angle of 63° from the vertex, and reappear at 5h. 41m. A.M. at an angle of 172° from the vertex. At 8h. 35m. P.M. on the 18th the 4½ magnitude star 30 Piscium will disappear at an angle of 147° from the vertex, and reappear at 9h. 41m. P.M. at an angle of 332° from the vertex, while at 10h. 27m. P.M. the same evening the 5th magnitude star 33 Piscium will disappear at an angle of 118° from the vertex, and reappear at 11h. 15m. P.M. at an angle of 12° from the vertex. The 4½ magnitude star ν Piscium will disappear on the 20th at 7h. 35m. P.M., at an angle of 118° from the vertex, and reappear at 8h. 49m. P.M. at an angle of 322° from the vertex. On the 21st the 7th magnitude star B.A.C. 741 will disappear at 3h. 8m. P.M. (in bright sunlight), at an angle of 37° from the vertex, and reappear at 3h. 53m. P.M. at an angle of 301° from the vertex, while at 5h. 16m. P.M. the 7th magnitude star B.A.C. 755 will make a near approach to the lunar limb at an angle of 177° from the vertex. At 3h. 13m. A.M. on the 22nd the 5th magnitude star 38 Arietes will disappear at an angle of 159° from the vertex, and reappear at 4h. 5m. A.M. at an angle of 310° from the vertex, the moon having set at Greenwich at the time. The planet Neptune will disappear at 9h. 7m. P.M. on the 23rd at an angle of 31° from the vertex, and reappear at 9h. 38m. P.M. at an angle of 351° from the vertex. This will be an interesting phenomenon, owing to the convenient time and altitude at which it occurs, but the brightness of the moon will interfere with its observation in small telescopes. At the time of occultation the moon will be distant from the earth about 240,980 miles, and the planet about 2,689,500,000 miles. At 10h. 40m. P.M. on the 25th the 7th magnitude star 5 Geminorum will disappear at an angle of 62° from the vertex, and reappear at 11h. 58m. P.M. at an angle of 297° from the vertex. At 3h. 52m. A.M. on the 27th the 6½ magnitude star 52 Geminorum will make a near approach at an angle of 211° from the vertex. At 6h. 29m. P.M. on the 28th the 4½ magnitude star γ Cancri will make a near approach at an angle of 321° from the vertex. The 61 magnitude star B.A.C. 3,579 will disappear at 10h. 43m. P.M. on the 30th at an angle of 325° from the vertex, and reappear at 11h. 8m. P.M. at an angle of 281° from the vertex. At 0h. 30m. A.M. on the 31st the 6th magnitude star *i* (46) Leonis will disappear at an angle of 358° from the vertex, and reappear at 1h. 33m. A.M. at an angle of 253° from the vertex.

[Mr. Sadler will commence, in "The Face of the Sky" for January, to give notice of some of the more remarkable astronomical phenomena which may be observed in the United States and India; and will not confine himself, as hitherto, to phenomena observable in England.—EDITOR.]

ERRATUM.—On p. 259, col. 2, five lines from the bottom, *for* "E and W" *read* "ϵ and ω."

XUM

Chess Column.

(CONDUCTED BY I. GUNSBERG.)

THE STEINITZ TSCHIGORIN CORRESPONDENCE MATCH.

By G. H. D. GOSSIP.

The following are the moves in the two games of this interesting contest up to date.

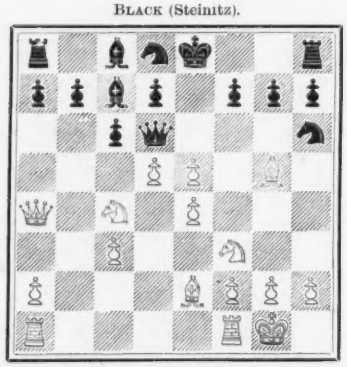
GAME I.

"Evans Gambit."

WHITE (Tschigorin).	BLACK (Steinitz).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to B4	3. B to B4
4. P to QKt 4	4. B×KtP
5. P to B3	5. B to R4
6. Castles	6. Q to B3 (*a*)
7. P to Q4	7. Kt to R3
8. B to KKt5	8 Q to Q3
9. P to Q5	9. Kt to Qsq
10. Q to R4	10. B to Kt3
11. Kt to R3	11. P to QB3
12. B to K2	12. B to B2
13. Kt to QB 4 (*b*)	

Position after White's 13th Move.

BLACK (Steinitz).



WHITE (Tschigorin).

Notes to Game I.

(*a*) Steinitz's pet defence, which, however, is not liked by Mackenzie and other eminent experts, on account of its rendering Black's game exceedingly cramped and difficult. We believe it, however, to be theoretically sound.

(*b*) 13. Q to Bsq is apparently Black's best move at this stage. We think now that Black will be able to wriggle out of his difficulties and emerge with a pawn ahead. For suppose now: 14. P to Q6, B×P; 15. Q to R5, Kt to K3, etc. If 15. Kt×B, Q×Kt; 16. B×Kt, K×B; 17. Q to R5 ch, P to Kt3; 18. Q×KP, Q×Q; 19. Kt×Q, R to Ksq, and Black should win. There are, of course, many other variations, but all should result in favour of Black. We confidently predict a victory for Steinitz in this game.

GAME II.

"Two Knights' Defence."

WHITE (Steinitz).	BLACK (Tschigorin).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to B4	3. Kt to B3
4. Kt to Kt5	4. P to Q4
5. P×P	5. Kt to QR4
6. B to Kt5 ch	6. P to B3
7. P×P	7. P×P
8. B to K2	8. P to KR3
9. Kt to KR3 (*a*)	9. B to QB4 (*b*)
10. P to Q3	10. Castles
11. Kt to B3	11. Kt to Q4
12. Kt to R4	12. B to Q3
13. Kt to Ktsq (*c*)	13. P to KB4
14. P to QB3	14. B to B2

Notes to Game II.

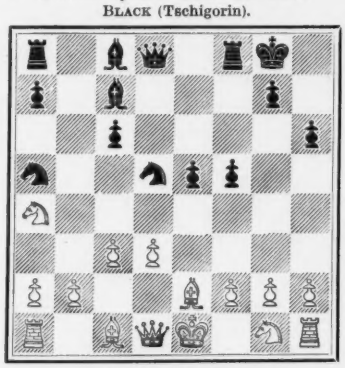
(*a*) Another of Steinitz's original but unpopular innovations.

(*b*) We infinitely prefer this move to 9. B×Kt, the line of play indicated by Steinitz in the *Modern Chess Instructor*.

(*c*) Thus White loses two moves with this Knight, and we consider Black's superior position and development to be an adequate compensation, even in a correspondence game, for his Pawn *minus*. We think that Black should at least obtain a draw in this game, as the Black Pawns on the King's flank threaten a dangerous attack.

Position after Black's 14th Move.

BLACK (Tschigorin).



WHITE (Steinitz).

CHESS INTELLIGENCE.

Mr. Gunsberg has sailed for New York *en route* for Havannah to play his match with Mr. Steinitz, which cannot fail to arouse interest both on account of the previous achievements and the contrast in the different styles of play of these two chess athletes. It will be remembered that Tschigorin was beaten rather easily by Steinitz in a set match in Cuba by ten to six games, and that Gunsberg has since played a drawn match with Tschigorin at Havannah; but although Gunsberg came out half a point behind Tschigorin in the New York International Tournament last year, we consider him to be slightly superior to the Russian champion, alike on the strength of previous performances and the style of his play. Whereas, however, Gunsberg's play is remarkably ingenious and brilliant, that of Steinitz is solid as a rock. Steinitz has not inaptly been termed the Michael Angelo of chess; but although Steinitz has played some of the most brilliant games on record, the general characteristics of his style are patience, originality, solidity, and, above all, tenacity and endurance. The plodding tenacity and profundity of his Pawn and position play are well known, and he alone of living players has never been defeated in a set match; and although a much older man than Gunsberg, he is still in full possession of all his faculties, so that the English representative, whose health is by no means robust, will have a hard task to wrest the sceptre of chess from its hitherto invincible champion.

To turn from great things to small, the handicap tournament at Simpson's Chess Divan is now approaching completion. The first and second prizes fall to Lee and Muller, *ex æquo*, 14 each; whilst the third and fourth will be secured by Gossip and Curnock, with scores of 12 and 11½ respectively. As the latter, however, has still one more game to play, he may come out third or fourth or tie, according to the result of his game with Osborne. The leading scores of the non prize-winners are Mortimer, 11½; Jadnograzky and Van Vliet, 10 each.

CONTENTS OF No. 61.

	PAGE
Giant Land Reptiles. By R. Lydekker, B.A.Cantab.	243
The Breathing Organs of Plants. By J. Pentland Smith, M.A., B.Sc.	246
Coloured Stars. By J. E. Gore, F.R.A.S.	249
The Bed-Bug.—III. By E. A. Butler	251
Notices of Books	253
The Annular Nebula in Lyra. By A. C. Ranyard	253
The Coal-Fields of Central France. By G. W. Bulman, M.A., B.Sc.	254
Letters:—G.Daniel, C.Parkinson, F. Pincott, A. B. MacDowall, G. E. Lumsden	257
The Face of the Sky for November. By Herbert Sadler, F.R.A.S.	259
Whist Column. By F. S. Hughes, B.A.Cantab	260
Chess Column. Conducted by I. Gunsberg	261

TERMS OF SUBSCRIPTION.

"KNOWLEDGE" as a Monthly Magazine cannot be registered as a Newspape for transmission abroad. The Terms of Subscription per annum are therefore altered as follows to the Countries named:

	s.	d.
To West Indies and South America	9	0
To the East Indies, China, &c.	10	6
To South Africa	12	0
To Australia, New Zealand, &c.	14	0

To any address in the United Kingdom, the Continent, Canada, United States and Egypt, the Subscription is 7s. 6d., as heretofore.

Communications for the Editor and Books for Review should be addressed Editor of "KNOWLEDGE," care of DAVID STOTT, 67 Chancery Lane, W.C.

XUM